SCIENCE.

FRIDAY, DECEMBER 7, 1883.

JOACHIM BARRANDE.

II., HIS SCIENTIFIC WORK.

THE influence of Barrande upon science in this country and throughout Europe has been of the first importance; and he has done much for the reputation of many of our investigators by his careful attention to their works, and his respectful quotations. He recognized the work especially of Dr. E. Emmons, and gave him the credit of being the discoverer of the primordial fauna, which Emmons had previously published as being in the Taconic system. Barrande thus ranged himself, during the celebrated Taconic controversy, on the side of Dr. Emmons, and his principal supporter in this country, Professor Jules Marcou. One of M. Barrande's most remarkable discoveries related to what he has called 'colonies.' According to him, certain characteristic fossils appeared sporadically in the faunas preceding those to which they properly belonged; and he deduced from this the result that two faunas having some identical species, but existing in different parts of the world, were not necessarily contemporaneous because of this fact, but might, indeed, be very distinct in age. These views are strongly supported by Professor Jules Marcou in this country, who states that he has discovered similar colonies in the rocks of the Taconic, underlying the Potsdam at Swanton and Phillipsburg; and is opposed principally by English authors upon the grounds that the evidence was stratigraphically defective. Barrande's reply to this, which he was preparing at the time of his death, has not yet been published. The theory has the support of the geologists of Vienna, especially Haidinger, director of the Imperial museum, whom Barrande quotes upon the titlepage of each of his books upon the 'colonies.'

From 1846 to the present time, the smaller publications of this voluminous and accurate writer must have reached nearly a hundred. Of these, between seventy and eighty were made to learned bodies, and from sixteen to twenty were pamphlets and books of octavo size: some of these were abridgments of his larger volumes. In the latter series, his *études*, extracts, etc., he published over three thousand pages and twenty-nine plates. Of these, his 'Cephalopodes, études générales,' was the most important to the general student. His grand work, the publication of which was begun in 1852, and is not yet finished, has already reached, as we have said, the number of twenty-two quarto volumes. These treat of the Trilobites and Crustacea, 1,582 pages, 84 plates; Cephalopoda, 3,600 pages, 544 plates; Brachiopoda, 226 pages, 153 plates; Acephala, 342 pages, 361 plates; and he announces as having already completed over 100 plates of the Gasteropoda, which have not yet appeared. This makes the enormous number of 5,750 pages of text in quarto, and 1,148 plates already issued, which we estimate as containing about eighteen thousand figures of fossils of the finest execution.

Barrande published large editions of his smaller works, which he distributed with a free hand to many institutions and scientific men; but of his larger works, the edition, probably on account of the expense, was limited to two hundred and fifty copies. The larger number of these he also gave away to scientific institutions and to individual geologists, and it is estimated that he did not receive in return as much as the actual cost of three of the large volumes.

The Gasteropoda, Echinodermata, Bryozoa, and miscellaneous fossils still remain unpublished; though over a hundred plates of the Gasteropoda were completed, and the text was being printed, at the time of his death.

The number of species described amount to thirty-six hundred. When we reflect that each

of these had to be studied, and handled over and over again many times, before reaching the final stages of classification, description, and illustration, we are amazed at the industry and capacity required to do all this scientific work single-handed. Barrande, unlike other voluminous authors, had no collaborators. With the exception of an amanuensis, draughtsmen, mechanical preparators, and mere collectors, he did all of this vast work. A careful and comprehensive system was followed in every volume, and in the descriptions of each species; so that, when one has mastered the intricacies of this, he can at once find every thing relating to the history, literature, structure, relations in time, and geographical distribution, of any species or group.

Finally, in the cephalopods, the parts and internal structures for which this fossil type is remarkable, as well as the embryo shells and their characteristics, are followed out in the same way. We will speak more at length of this type, partly because it was the favorite and most fruitful field of research of this eminent author, and was selected by him as the stronghold from which to attack the theory of evolution, and partly because we have no space to do justice to other departments, where he, however, made important discoveries; as, for example, among the trilobites. With infinite labor he succeeded in getting series showing the stages of growth of some species among these ancient Crustacea, and taught us that it was possible to study their development even in the Silurian period. Barrande's efforts have been frequently referred to as if he were one of what we might call the numismatic school of geologists, who study animal fossils as if they were medals, useful principally to verify the date and place of formations. On the contrary, his technical labors had a distinctly ideal purpose, — the investigation of the evidences for and against the theory of evolution. His education and consequent psychological condition placed him in opposition, and, in spite of his honest efforts to treat the subject fairly, controlled his classifications, and warped his judgment. The Cuvierian form of anthropomorphology was his faith; and he failed, as have most great executive men, in realizing the dangers of his own mental training, and the need of correcting the personal equation.

The facts, however, were strong enough even to meet his requirements in some of the groups he studied; yet he ended by admitting that evolution must, in part at least, be true. He believed that the different types were miraculously created, but that the smaller series which he had traced might have been evolved within certain well-defined limits, fixed according to the plans of an infinite intelligence, which it was hopeless to try to understand. He was also deficient in that sort of zoölogical knowledge which is acquired only by research among existing animals, and a familiarity with their modes of development, anatomy, and habits. This explains the apparent inconsistencies which show themselves in his text: — the continual admission of transition forms between different species and smaller groups, and yet the perpetual denial of the probable former existence of any such transitions between what he considered distinct types, whenever he could not actually find them; his comparisons between the Silurian and recent Nautili, which he supposed to be very similar, when in reality only their adults are similar, the young shells and their developmental stages being widely different; his singular opinion that species like these Silurian Nautili and other forms, which seemed to him out of place and also inexplicable on account of their structure, had been set in the geological record as intentional exceptions, to teach man the divine origin of this apparently modified chaos of gradations. Barrande understood, and gave a fair statement of, the ordinary views of evolutionary embryologists on p. 74 of his 'Études générales, Cephalopodes,' and represented a naturalist of this stamp investigating the embryos of the fossil Nautiloidea. After finding all the forms of the group from the Silurian to the present time with the same type of apex or young, he would then necessarily draw from this embryo a picture of the lost prototypical ancestor of all the Nautiloidea. In his next steps he would find the

adults of transition forms from Nautiloidea to Ammonoidea, and set down his convictions that the Ammonoidea must have been derived from Nautilus through these transition forms, the gradations being Nautilini, Goniatites, Ammonites. Barrande then pictures this same naturalist as attempting to verify his apparently well-founded conclusions by opening a species of Goniatite with the anticipation of discovering within, at the apex, or young shell, an identical form and structure to that which he had been accustomed to find in the Nautiloidea, and his consequent confusion, and the overthrow of his theory, upon the exposure of a different form. Barrande's argument deals fairly with every point; and his facts are crushing refutations of the usual direct, simple modes pursued by embryologists in handling the question of the evolution of types. Barrande's work had no orators or lecturers to translate it; and the hypothesis of the embryologists, and even evolution itself, escaped an attack, which, if supported by powerful influences, might have shaken the popular faith in the new school of thought.

Hyatt has denied that there were such great and essential differences between the embryos of the Nautiloidea and those of the Ammonoidea; and they certainly seem to have been more alike than was supposed by M. Barrande. The fact, however, remains, that Barrande saw clearly that the embryos of these two nearly allied groups, which are united by most authors into one order, were, even in the Silurian, more easily separable from each other than some of the adult forms. When we can add to this, his discovery and thorough demonstration of the distinctness of the different types of fossils in the Silurian, and their sudden mode of appearance, we see clearly that he succeeded in doing the work which has thrown the greatest light upon the most obscure and interesting periods of the world's history, and which has furnished a temperate and healthy opposition to the theory of evolution. His faults of logic were unavoidable, with his mathematical and Cuvierian education, and strong feelings of loyalty to his masters in science; but these are only slight scratches upon the face of the vast monument erected by his labors, his discoveries, his eighty-three years of unblemished moral and faithful life, and his personal sacrifices for the advancement of science and the truth.

WHIRLWINDS, CYCLONES, AND TORNADOES.[1] — V.

CYCLONIC circulation has thus far been described as if it were effected in radial lines in to and out from the centre; but here, as in the whirlwind, perfect radial motion is impossible. A horizontal rotary motion would soon be established near the centre by the inequality of the inblowing winds. It is found, however, that all storms yet studied turn from right to left in the northern hemisphere, and from left to right in the southern (fig. 9). Such constancy points to something more regular than the accidental strength of the winds, — to some cause that shall always turn the indraughts to the right of the centre as they run in towards it in the northern hemisphere, and to the left in the southern hemisphere; and this cause is found in the rotation of the earth on its axis.

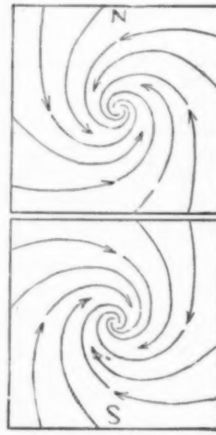


FIG. 9.

There is a force arising from the earth's rotation that tends to deflect all motions in the northern hemisphere to the right, and in the southern to the left; and this deflecting force varies with the latitude, being nothing at the equator, and greatest at the poles. It may be found that this statement differs from that generally made: namely, that moving bodies are deflected only when moving north or south, and not at all when moving east or west: for it is thus that Hadley (1735) and Dove (1835) explained the oblique motion of trade-winds, and that Herschel and others explained the rotation of storms. But this is both incorrect and incomplete; for a body moving eastward is deflected as well as when moving northward, and the actual deflective force is greater than that accounted for in Hadley's explanation.

[1] Continued from No. 43.

It is this deflective force, acting on winds from all sides, as was first shown by Tracy[1] (1843), that combines with the centripetal tendency of the surface-winds to give rise to the inward spiral blowing of the storm (fig. 10), — a constant feature of all cyclones.

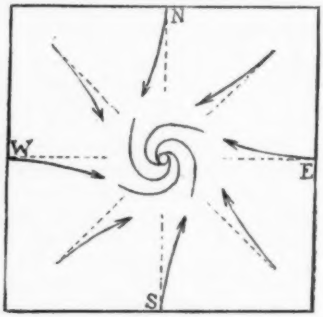


FIG. 10.

In all hurricanes, the winds greatly increase in strength as they near the centre of the storm, and at the same time their path becomes more nearly circular. A cause of this was briefly stated for the whirlwinds: but it now must be more fully analyzed; and it will be best to begin the attempt by resolving the motion of the wind at any point of its spiral track into two rectangular components (fig. 11), — one, along a radius toward the centre, *P R*, the centripetal component; the other, circular or tangential, *P T*. Only the first of these comes directly from the convectional circulation, already described as depending on the central warmth: and this one would never produce winds of devastating strength. The second, or tangential, arises first from the deflective force of the earth's turning. The higher the latitude, the less the friction at the bottom of the atmosphere, and the greater the distance from which the wind is derived, then the greater its right-handed departure from a radial path. Hence in a large storm at sea, where the friction is small, and the indraught has its source several hundred or even a thousand miles away from the centre of low pressure, the deflective tangential component becomes very considerable, and may, near the centre, outrank the centripetal.

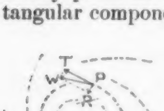


FIG. 11.

[1] See SCIENCE, i. 98.

But there is another and even more important cause of growth in the circular element of the wind's motion; namely, the increase of its rotary velocity as the radius of rotation decreases, in accordance with the law of the 'preservation of areas,' already mentioned. Let us suppose, that, when at a distance of five hundred miles from the centre, the inblowing wind has been turned to the right of its radial path by the earth's deflective force so as to have the moderate tangential or rotary velocity of one mile an hour; and, disregarding the further effects of deflection, let us consider the consequences of gradually drawing this mass of air towards the centre. The product of its radius and its rotary velocity must remain constant; and hence, as the radius is diminished, the velocity must increase, one quantity varying inversely as the other. The wind has no visible, material connection with the storm-centre; but it is slowly moving around that centre, under the control of central forces, derived from differences of temperature and pressure, that drive it inwards, or, in other words, shorten its radius of rotation: and consequently, when, in the case supposed, the radius has been diminished to five miles, the velocity must have been accelerated to one hundred miles an hour, — a violent hurricane-wind. The recognition of this important factor of the storm's strength is due to Ferrel (1856). The theoretical increase of velocity thus provided is never fully realized, for much motion is overcome by friction; but enough is preserved, especially in tropical storms, to give them the greatest share of their destructive strength. The total tangential component of the wind at any point must therefore be considered as the sum of the deflective and accelerative forces, minus the loss by friction. Near the storm-centre, where the velocity of the wind is very great, this tangential component is much greater than the centripetal, and the spiral path becomes almost circular; while the reverse relation holds for the outer part of the storm.

It will be easily understood, that a considerable centrifugal force will be developed by the rapid central rotations, as well as by the earth's deflective force; and, as a consequence, the centripetal force will be partly neutralized, and the winds will be held out from the centre. This must increase the depression already produced there by expansion and overflow; and, as a matter of fact, the low pressure of a storm-centre, especially in tropical latitudes, is chiefly the effect of this dynamic, and not of the earlier named static cause. But so long as the wind maintains its rapid motion, the additional

depression is powerless to draw it towards the centre. Only when its velocity is decreased by friction does the barometric gradient, just before produced by the centrifugal force, urge the wind inwards to the middle of the storm. The additional gradient, therefore, represents potential energy, derived from the actual energy of the rotating winds, and all ready to be transformed into actual energy again, as soon as friction has destroyed some of the velocity of rotation.

The general interaction of the storm-forces may now be thus summarized: in obedience to a centripetal tendency, produced by differences of temperature or of pressure, or both, the air moves along the surface to the region of low pressure. On its way, the deflective force arising from the earth's rotation turns it continually to one side, and so gives it a more and more nearly circular path; and, in addition to this, its rotary velocity increases as much as its radius of rotation decreases: the tangential component of its spiral motion must therefore continually increase. With the increase of this component, and the decrease of the radius of rotation, the centrifugal force ($v^2 \div r$) must increase rapidly, and soon come to equal and counterbalance the original centripetal force, and at the same time greatly increase the barometric gradients. At this point the wind would blow in a circular path, were it not that friction with the sea or ground is continually consuming some of its velocity, and thus decreasing its centrifugal force, and allowing the potential energy of the steep barometric gradient to produce centripetal motion. This decreases its radius, and at once gives it new life, again to be partly destroyed and renewed as before. Absolutely circular motion can therefore never be attained, although it is approached very closely near the centre. At sea, where friction is small, and in tropical latitudes, where the strength of the storm is great, the wind is unable to reach the storm-centre; for, when the distance from the centre is reduced to only five or ten miles, the centrifugal force is so great, and the wind's course is so nearly circular, that it is carried aloft by the up-draught before it can enter noticeably farther: the central area is therefore left unprovided with violent winds, and is generally a comparative calm, known as the 'eye of the storm,' of which there will be more to say later. The general form of the storm-wind's spiral can be deduced from the preceding considerations. The angle between the tangential component and the actual path of the wind, which is called the inclination (fig. 11.), will vary with the relation of the circular and centripetal elements of the wind's motion; the tangent of the inclination will equal the radial divided by the tangential component: hence in the outer part of the storm the inclination will be large, and the wind will blow almost directly toward the storm-centre; but nearer the centre the inclination will become smaller and smaller, and the wind will blow in a more and more nearly circular path. It will also be understood, that the upper winds, less influenced by friction, will near the centre have a greater velocity and a less inclination than the lower ones. Moreover, the inward gradient which they produce will be effective and important in urging along the slower surface-winds, in a manner better illustrated in a tornado, where this action will be more fully described.

(*To be continued.*)

ON THE DEVELOPMENT OF TEETH IN THE LAMPREY.

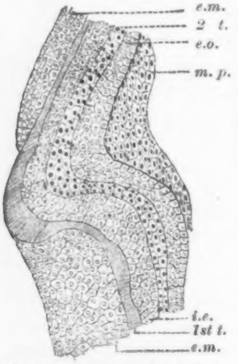
THE teeth in the myxinoid fishes are quite different from those of other vertebrates, and have hitherto been supposed to belong in an entirely different category. Nothing has been known with regard to their development, except a brief statement as to their mode of succession in Petromyzon by Professor Owen, in his 'Odontography.'

The teeth of the lamprey are horny, and of simple conical shape, disposed concentrically in the dome-shaped mouth. Besides these, there are horny lingual and palatal teeth.

The kindness of my friend Professor Benecke of Königsberg, who sent me a number of lampreys at the end of their metamorphosis from Ammocoetes, has enabled me to follow out the development of these horny teeth with unexpected results; for, as far as the essential part of the process is concerned, it differs but slightly from the normal course of true dental development. There is first formed a low conical papilla of somewhat reticulate tissue, belonging to the mesoblast (*m.p.*), and continuous with the dermis, which in this, as in other vertebrates, is of mesoblastic origin. Over this papilla the epiblast which lines the cavity of the mouth becomes extremely thick, and consists of very numerous layers of cells. All of these layers can be continuously traced into the other epiblast of the mouth, as well as that of the external skin. In the stage here figured there may be seen, immediately overlying the mesoblastic papilla, a layer of epiblastic cells irregularly columnar and polygonal in shape (*e.o.*). These cells are the homologue of the

enamel-organ of the other vertebrates, and originate in the same way. So far, at least, the lamprey does not show an essentially different type of tooth-development from that known in other groups.

The cells of the 'enamel-organ' are rapidly proliferating, and have thrown off from their outer surface a conical cap of cells (*2d t.*), which are flattened, and which show an incipient formation of pigment among them. This hollow cone of cells is the rudiment of the youngest tooth, which in the stage here described is the second of the series. Outside of the rudimentary tooth is a cone of polygonal epiblastic cells, several layers deep (*i.e.*); and this is again followed by the first tooth, now almost completely cornified and pigmented, so that traces of cellular structure are but faintly discernible (*1st t.*). The tip of this tooth has just penetrated the skin of the mouth, and is elsewhere covered by the many-layered epiblast (*e. m.*).



Section through inner side of lip of metamorphosing lamprey. *e.m.*, epiblast of mouth; *1st t.*, oldest tooth; *2d t.*, youngest tooth; *e.o.*, enamel-organ; *i.e.*, intermediate epiblast-cells between successive teeth; *m.p.*, mesoblastic papilla.

We see, therefore, that the essential parts of the typical vertebrate tooth are here present; namely, the mesoblastic papilla, and the over-lying epiblastic enamel-organ. But the ordinary type of dental development is here greatly modified. The papilla is never ossified; and the enamel-organ secretes no enamel, but functions as a sort of tooth-gland, throwing off successive hollow cones of flattened and cornified epiblastic cells. The actual tooth of the lamprey is therefore not the homologue of the entire tooth of a selachian, but simply of the enamel-cap. It is not difficult, however, to understand how the process seen in Petromyzon could be derived from that in the selachian. In consequence of this change, another difference arises: as the papilla never ossifies or becomes protruded, it is no longer necessary that for every new tooth a new enamel-organ should be formed by budding from the old one; so each enamel-organ is converted into a permanent tooth-gland, functional throughout the life of the animal.

This view of the peculiarities of dental development in Petromyzon implies, of course, that this group of fishes was derived from ancestors possessed of teeth of the ordinary or selachian type. Further, as it is now very generally admitted that teeth are only modified placoid scales, it follows that the lampreys are descended, ultimately at least, from forms provided with placoid scales.

Such a conclusion, however, does not by any means commit us to the view that the myxinoids are degenerate descendants of some gnathostomatous group, as this is no more implied in the possession of ordinary calcareous teeth than in the presence of the horny teeth which the group has long been known to possess.

W. B. SCOTT.

Morphological laboratory, Princeton, N.J., Nov. 3, 1883.

NORDENSKIÖLD ON THE INLAND ICE OF GREENLAND.[1]

IN a series of letters to Mr. Oscar Dickson, Baron Nordenskiöld has given a detailed report of the leading incidents and results of his recent expedition, though it will still be some time ere we can learn what are the full gains to science. The leading novelty of the expedition was, of course, the journey into the interior of Greenland.

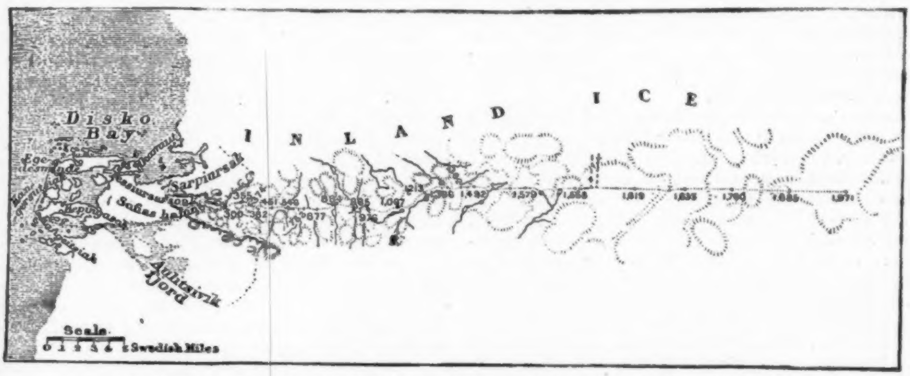
After landing Dr. Nathorst and his party at Waigatz Sound, Nordenskiöld went back to Egedesminde, which he reached on June 29. The following day he left for Auleitsivik Fjord, from which the expedition was to start. He then proceeds: —

On July 1 the Sophia anchored in the bay. We found here a splendid harbor with clay bottom, some seven fathoms deep, surrounded by gneiss rocks from six hundred to a thousand feet in height, the sides of which are in some places covered with low but close shrubs, or clothed with some species of willow, mosses, and lichen, which, when we arrived, were ornamented with a quantity of magnificent blossoms. From one of the slopes a torrent descended, the temperature of which was 12.3° C. The weather was fine, the sky cloudless, and the air very dry. July 1 to 3 were employed in making preparations for the ice-journey, while the naturalists made excursions to various places in order to collect objects relating to the conditions of the country. On the night of the 3d every thing was ready for a start; and, after some difficulty in reaching the spot where the baggage was, we were fairly off. The spot from which we set out on the journey was only five kilometres from the actual shore, and situated below a little lake into which a number of glacier rivers fell. We proceeded up the river in a Berton boat, purchased in England. On the night of the 4th we camped for the first time on the ice. The expedition consisted of nine men besides myself. After a great deal of hard work in getting the sledges over the ice, which was here very

[1] From *Nature*, Nov. 1 and 8.

rough, we found, on the morning of the 5th, that it was impossible to proceed eastwards, but were compelled to return to the border of the ice, and then continue to the north or north-east until finding smoother ice. This first part of the ice was furrowed by deep crevasses and ravines, causing us much trouble. We covered, however, a good distance that day, and pitched our tent near a land-ridge in the ice, two hundred and forty metres above the sea.[1] On July 6 I sent the Lapp Lars forward to reconnoitre; and he reported that it was still impossible to proceed eastwards, but, if we marched for a day or so to the north, we would find the country accessible to the east. As I feared, however, the impossibility of dragging the sledges with the weight on them over the rough ice, I selected provisions, etc., for forty-five days, and left the rest in a depot in the ice. We now resumed the march. It was very interesting to witness the great ease with which the Lapps proceeded among the ice-ravines, how easily they traced a road discovered, and with what precision they selected the least difficult track.

The Lapp Lars carried, instead of an alpenstock, a wooden club, with which he had slain more than twenty-five brown bears, full of marks from their teeth; and his eyes sparkled at the thought of encountering a white one. On the night of the 6th we held our third camp on the ice; and now several officers and men from the Sophia, who had accompanied us thus far, left us. Besides the most advantageous requisites for such a journey, we had with us a cooking-apparatus for petroleum: and here I beg to say that I found this kind of oil far more suitable than train or vegetable oils, which I had used on my former expeditions; and I recommend the same most warmly to arctic explorers. Of scientific instruments I may mention compasses, two chronometers, a circle by Pistor and Martin, a small sextant (in case of the former being damaged), a mercury horizon, three aneroid barometers, thermometers, magnets (for the study of the clay deposit in the snow), a topographical board, a photographic apparatus, blow-pipes, flasks, nautical tables, etc. The sledges, 'kalkar,' six in number, were of the same kind as those on which Swedish peasant women bring their wares to market. The harness was made so strong that it would hold a man, in case of his falling into a crevasse. In addition to these things, we had a Manila rope specially spun for the expedition at the Alpine purveyor's in Paris. The food supplied per day may perhaps interest explorers. It was, — breakfast, coffee, bread, butter, and cheese (no meat or bacon); dinner, forty-two cubic centimetres Swedish corn brandy (*bräntin*), bread, ham or corned beef, with sardines; supper, preserved meat, Swedish or Australian. Sometimes preserved soup was served with dried vegetables. Five men were teetotalers, but there was no need of supplying them with extra rations. For cooking, 0.7 litres of spirits were consumed per day. Our whole baggage weighed a ton, — a weight which might easily have been drawn across a smooth snow or ice field, but which was very difficult of transporting over the rough and cut-up surface we had to traverse. Our daily march between July 7 and 9 was therefore not great, viz., five kilometres a day. In addition to the crevasses and ravines, we encountered innumerable rivers, swift, and with steep banks, which were difficult of crossing, which was generally accomplished by laying three alpenstocks across them. If I had not selected these of the toughest wood obtainable, we should often have had to make *détours* of many kilometres.



THE HEIGHTS ARE GIVEN PROVISIONALLY IN METRES. SWEDISH MILE = 6.64 ENGLISH MILES.

On these days we found, on several occasions, large bones of reindeer on the snow; and it was but a natural and pardonable conclusion to arrive at, that they were those of animals who had fallen in their wandering over the 'Sahara of the arctic regions.' But that good signs are not always true ones we soon discovered.

[1] The altitudes were ascertained by comparing three aneroid barometers, while observation was simultaneously made at Egedesminde with a splendid sea-barometer I had left there for that purpose. As the figures have, however, not yet been verified, they may be slightly altered. They seem, on the whole, too low.

During the entire journey, we had great difficulty in finding suitable camping-places. Thus, either the ice was so rough that there was not a square large enough for our tent, or else the surface was so covered with cavities, which I will fully describe later on, that it was necessary to pitch it over some hundred smaller and a dozen larger round hollows, one to three feet deep, filled with water, or else to raise it on a snow-drift so loose and impregnated with water that one's feet became wet, even in the tent. An exception to this was the place where we camped on July 9; viz., camping-place no. 6. We encountered here a small ice-plain, surrounded by little rivers, and almost free from cavities, some thirty metres square. All the rivers flowed into a small lake near us, the water from which rushed with a loud roar through a short but strong current into an enormous abyss in the ice-plateau. The river rushed close to our tent, through a deep hollow, the sides of which were formed of magnificent perpendicular banks of ice. I had the spot photographed; but neither picture nor description can give the faintest idea of the impressive scene, viz., a perfectly hewn aqueduct, as if cut by human hand in the finest marble, without flaw or blemish. Even the Lapps and the sailors stood on the bank, lost in admiration.

At first we had followed the plan of bringing the baggage forward in two relays; but, finding this very fatiguing, I decided to bring all with us at once. I found this to answer better. On July 10 we covered thus nine and a half, on the 11th ten, and on the 12th eleven, kilometres. The road was now much better than before, although stiff enough. An exception to this was, however, formed by the part we traversed on the 11th, when we proceeded alongside a big river, the southern bank of which formed a comparatively smooth ice-plain, or rather ice-road, with valleys, hills, cavities, or crevasses, some five to ten kilometres in width, and five kilometres in length. This plain was in several places beautifully colored with 'red' snow, especially along the banks of the river. It was the only spot on the whole inland ice where we found 'red' snow or ice in any quantity. Even yellow-brown ice was seen in some places; but, on the other hand, ice colored grayish-brown or grayish-green, partly by kryokonite, and partly by organisms, was so common that they generally gave color to the ice-landscape.

Even on July 12, between camps nos. 7 and 8, we found blades of grass, leaves of the dwarf-birch, willows, crackberry, and pyrola, with those of other Greenland flora, on the snow. At first we believed they had been carried hither from the interior; but that this was not the case was demonstrated by the circumstance that none was found east of camp no. 9. The only animals we discovered on the ice were, besides the few birds seen on our return-journey, a small worm which lives on the various ice algae, and thus really belongs to the fauna of the inland ice, and two storm-driven birds from the shore. I had particularly requested each man to be on the lookout for stones on the ice; but, after a journey of about half a kilometre from the ice-border, no stone was found on the surface, not even one as large as a pin's point. But the quantity of clay-dust ('kryokonite') deposited on the ice was very great, — I believe, several hundred tons per square kilometre.

We now ascended very rapidly, as will be seen from the subjoined statement of our camps: —

3d	camp,	300	metres above	the sea.
4th	"	355	"	"
5th	"	374	"	"
6th	"	382	"	"
7th	"	451	"	"
8th	"	546	"	"
9th	"	753	"	"

The 9th camp lay on the west side of an ice-ridge close by a small, shallow lake, the water from which gathered, as usual, into a big river, which disappeared in an abyss with azure-colored sides. From this spot we had a fine view of the country to the west, and saw even the sea shining forth between the lofty peaks on the coast; but, when we reached east of this ice-ridge, the country was seen no more, and the horizon was formed of ice only.

Through an optical illusion, dependent on the *mirage* of the ice-horizon, it appeared to us as if we were proceeding on the bottom of a shallow, saucer-shaped cavity. It was thus impossible to decide whether we walked up or down hill; and this formed a constant source of discussion between us, which could only be decided by the heaviness of the sledges in the harness. The Lapps, who seemed to consider it their sole business that we should not be lost on the ice, came to me in great anxiety, and stated that they had no more landmarks, and would not be responsible for our return. I satisfied them, however, with the assurance that I would find the way back by means of a compass and solar measurements. In spite of this, the Lapps easily traced our route and our old camps with an accuracy quite marvellous.

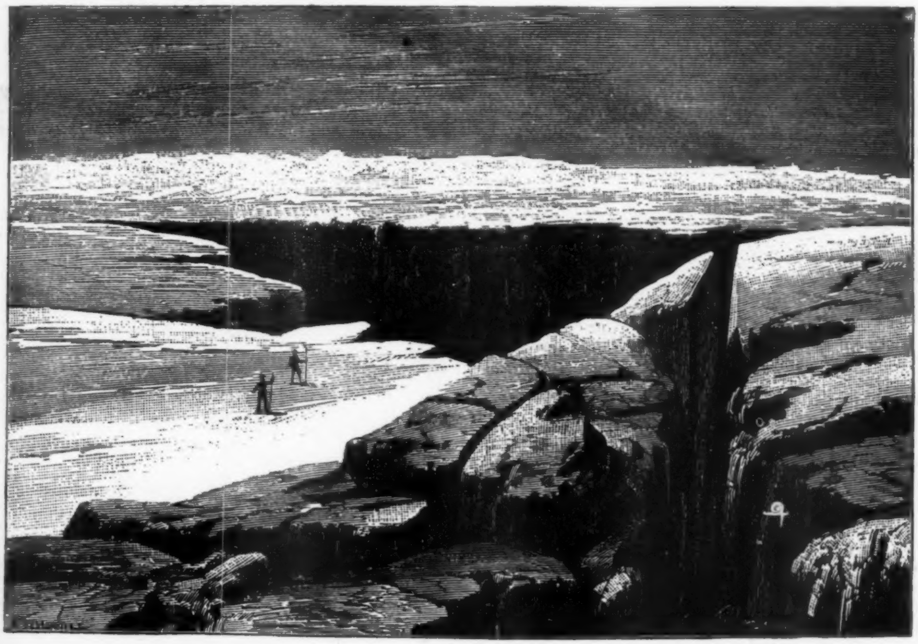
During our outward journey, I determined the site of each camp astronomically; and thus the distances which, when the determinations have been calculated, will be given on the map to be drawn of the journey, will be absolutely correct. But the distances covered by the Lapps have been made according to their own judgment. The kilometres we covered every day, including the numerous *détours*, were ascertained by two pedometers.

Up to the 9th camp we were favored by the finest weather, generally with a slight south-east wind, cloudless sky, and a temperature in the shade, three feet above the ice, of 2° to 8° C., and in the sun of even 20° C. The centre of the sun's disk sank in this spot for the first time below the horizon on July 15, and the upper rim, if allowance is made for refraction, on July 21. After the middle of July, when at an elevation of four thousand to seven thousand feet, the nights became very cold, the thermometer sinking to 15° and 18° below freezing-point of Celsius.

The constant sunshine by day and night, reflected from every object around, soon began to affect our eyes, — more so, perhaps, because we had neglected to adopt snow-spectacles at the outset of our journey; and snow-blindness became manifest, with its at-

tendant cutting pains. Fortunately Dr. Berlin soon arrested this malady, which has brought so many journeys in the arctic regions to a close, by distributing snow-spectacles, and by inoculating a solution of zinc vitriol in the blood-stained eyes. Another malady — if not so dangerous, at all events quite as painful — was caused by the sunshine in the dry, transparent, and thin air on the skin of the face. It produced a vivid redness and a perspiration, with large burning blisters, which, shrivelling up, caused the skin of the nose, ears, and cheeks, to fall off in large patches. This was repeated several times, and the pain increased by the effect of the cold morning air on the newly-formed skin. Any similar effect the sun has not in the tropics. With the exception of these complaints, none of us suffered any illness.

On July 13 we covered thirteen, on the 14th ten, and the 15th fourteen, kilometres (9th to 12th camps). At first the road gradually rose; and we then came to a plain, which I, in error, believed was the crest of the inland ice. The aneroids, however, showed that we were still ascending: thus the 9th camp lies 753, the 10th 877, the 11th 884, and the 12th 965, metres above the sea. Our road was still crossed by swift and strong rivers; but the ice became more smooth, while the kryokonite cavities became more and more troublesome. This was made more unpleasant by rain, which began to fall on the afternoon of July 13, with a heavy wind from south-east. It continued all the night, and the next morning turned into a snow-storm. We all got very wet, but consoled ourselves with the thought that the storm coming from south-east argued well for an ice-free interior. When it cleared a little, we strained our eyes to trace any mountains which would break the ice-horizon around us, which everywhere was as level as that of the sea. The desire soon 'to be *there*' was as fervent as that of the searchers of the Eldorado of yore; and the sailors and the Lapps had no shadow of doubt as to the existence of an ice-free interior; and at noon, before reaching camp no. 12, everybody fancied he could distinguish mountains far away to the east. They appeared to remain perfectly stationary as the clouds drifted past them, — a sure sign, we thought, of its not being a mass of clouds. They were scanned with telescopes, drawn, discussed, and at last saluted with a ringing cheer; but we soon came to the conclusion that they were unfortunately no mountains, but merely the dark reflection of some lakes farther to the east in the ice-desert.



Fissure in Greenland's inland ice, seen by Nordenskiöld on his visit in 1876. From a sketch by Dr. Berggren, published in *La Nature*.

In my report of the expedition of 1870, I drew attention to a clayey mud which is found in circular cavities, from one to three feet in depth, on the surface of the inland ice, not only near the shore, but even as far inland as we reached on that occasion.

My companion on that occasion, Professor Berggren, discovered that this substance formed the substratum of a peculiar ice-flora, consisting of a quantity of different microscopical plants (algae), of which some are even distributed beyond the clay on the ice itself, and which, in spite of their insignificance, play, beyond doubt, a very important part in nature's economy, from the fact that their dark color far more readily absorbs the sun's heat than the bluish-white ice, and thereby they contribute to the destruction of the ice-sheet, and prevent its extension. Undoubtedly we have in no small degree to thank these organisms for the melting-away of the layer of ice which once covered the Scandinavian peninsula. I examined the appearance of this substance in its relation to geology, and demonstrated, —

1. That it cannot have been washed down from the mountain ridges at the sides of the glaciers; as it was found evenly distributed at a far higher elevation than that of the ridges on the border of the glaciers, as well as in equal quantity on the top of the ice-knolls as on their sides or in the hollows between them.

2. That neither had it been distributed over the surface of the ice by running water, nor been pressed up from the hypothetical bottom 'ground' moraine.

3. That the clay must therefore be a sediment from the air, the chief constituent of which is probably terrestrial dust spread by the wind over the surface of the ice.

4. That cosmic elements exist in this substance, as it contained molecules of metallic iron which could be drawn out by the magnet, and which, under the blowpipe, gave a reaction of cobalt and nickel.

Under these circumstances, the remarkable dust which I have named 'kryokonite,' i.e., ice-dust, obtained a great scientific interest; particularly as the cosmic element, viz., the matter deposited from space, was very considerable. Even later students who have visited the inland ice have observed this dust, but in places surrounded by mountains, from which it might with more probability have been washed down. They have, therefore, and without having examined Professor Berggren's and my own researches of 1870, paid little attention to the same; while the samples brought home by Dr. N. O. Holst from South Greenland in 1880 were not very extensive.

But now Dr. Berlin brings home from a great variety of places ice algae, which, I feel convinced, will contribute fresh materials to our knowledge of the flora of the ice and snow. For my own part, I have re-examined my first researches of the kryokonite, and they are fully corroborated. Everywhere where the snow from last winter has melted away, a fine dust, gray in color, and, when wet, black or dark brown, is distributed over the inland ice in a layer which I should estimate at from 0.1 to 1 millimetre in thickness, if it was evenly distributed over the entire surface of the ice. It appears in the same quantity in the vicinity of the ice-border surrounded by mountains as a hundred kilometres inland; but in the former locality it is mixed with a very fine sand, gray in color, which may be separated from the kryokonite. Farther inland this disappears, however, completely. Gravel or real sand I have never, in spite of searching for them, discovered in the kryokonite. The kryokonite always contains very fine granular atoms, which are attracted by the magnet, and which, as may be demonstrated by grating in an agate mortar and by analysis under the blowpipe, consist of a gray metallic element; viz., nickel iron. In general, the dust is spread equally over the entire surface of the ice. Thus it was found everywhere where the snow from the previous year had melted away; while, to judge by appearances, there seemed to be little difference between the quantity found near the coast, and in the interior. The dust does not, however, form a continuous layer of clay, but has, by the melting of the ice, collected in cavities filled with water, which are found all over the surface. These are round, sometimes semicircular, one to three feet in depth, with a diameter of from a couple of millimetres to one metre or more. At the bottom a layer of kryokonite one to four millimetres in thickness is deposited, which has often, by organisms and by the wind, been formed into little balls; and everywhere where the original surface of the ice has not been changed by water-currents, the cavities are found so close to each other that it would be very difficult to find a spot on the ice as large as the crown of a hat free from them. In the night, at a few degrees below freezing-point, new ice forms on these hollows; but they do not freeze to the bottom, even under the severest frost, and the sheet which covers them is never strong enough to support a man, more particularly if the hole is, as was the case during half our journey, covered with a few inches of newly-fallen snow.

The kryokonite cavities were perhaps more dangerous to our expedition than any thing else we were exposed to. We passed, of course, a number of crevasses without bottom as far as the eye could penetrate, and wide enough to swallow up a man; but they were 'open,' i.e., free from a cover of snow, and could with proper caution be avoided; and the danger of these could further be minimized by the sending of the two-men sledges in front, and, if one of the men fell into the crevasse, he was supported by the runners and the alpenstock, which always enabled him to get up on the ice again. But this was far from being the case with the kryokonite hollows. These lie, with a diameter just large enough to hold the foot, as close to one another as the stumps of the trees in a felled forest; and it was therefore impossible not to stumble into them at every moment, which was the more annoying as it happened just when the foot was stretched for a step forward, and the traveller was precipitated to the ground with his foot fastened in a hole three feet in depth. The worst part of our journey was four days outward and three days of the return; and it is not too much to say that each one of us, during these seven days, fell a hundred times into these cavities, viz., for all of us, seven thousand times. I am only surprised that no bones were broken, — an accident which would not only have brought my explo-

ration to an abrupt close, but might have had the most disastrous consequences, as it would have been utterly impossible to have carried a man in that state back to the coast. One advantage the kryokonite cavities had, however; viz., of offering us the purest drinking-water imaginable, of which we fully availed ourselves without the least bad consequences, in spite of our perspiring state.

On July 16 we covered thirteen, on the 17th eighteen and a half, and on the 18th seventeen and a half, kilometres. The country, or more correctly the ice, now gradually rose from 965 to 1,213 metres. The distances enumerated show that the ice became more smooth; but the road was still impeded by the kryokonite cavities, whereas the rivers, which even here were rich in water, became shallower but stronger, thus easier of crossing. Our road was, besides, often cut off by immense snow-covered crevasses, which, however, did not cause much trouble.

On the night of the 18th, when arrived at camp no. 14, the Lapp Anders came to me and asked if he might be permitted to 'have a run;' viz., to make a reconnaissance on 'skidor,'[1] to see if there was no land to the east. This granted, he started off without awaiting supper. He came back after six hours' absence, and reported that he had reached twenty-seven kilometres farther east; that the ice became smoother, but was still rising; but there was no sign of land. If his statement was true, he had, after a laborious day's journey, in six hours covered about sixty kilometres! At first I considered his estimate exaggerated, but it proved to be perfectly correct. It took us, thus, two whole days to reach as far as he had got, as shown by the track in the snow. I particularly mention this occurrence in order to show that the Lapps really did cover the estimated distance of their journey eastward, of which more below.

During these days we passed several lakes, some of which had the appearance of not flowing away in the winter, as we found here large ice-blocks several feet in diameter, screwed up on the shore; which circumstance I could only explain by assuming that a large quantity of water still remained here when the pools about became covered with new ice. The lakes are mostly circular, and their shores formed a snow 'bog' which was almost impassable with the heavy sledges.

On July 19 we covered seventeen and a half, on the 20th sixteen and a half, on the 21st seven, and on the 22d seven and a half, kilometres (15th to 18th camp). The ice rose between them from 1,213 to 1,492 metres. The distances enumerated fully show the nature of the ice. It was at first excellent, particularly in the morning, when the new snow was covered with a layer of hard ice; but on the latter days we had great difficulty in proceeding, as a sleet fell with a south-east wind in the night, between the 20th

[1] The Swedish 'skidor' and Norwegian 'ski' are long strips of pine wood, slightly bent at the top, polished, and as elastic as if they were of the finest steel, with a strap for the feet in the centre, on which the Lapps and Scandinavians run on the snow with remarkable agility at a tremendous pace.

and the 21st. The new snow, as well as that lying from the previous year, became a perfect snow-bog, in which the sledges constantly stuck, so that it required at times four men to get them out. We all got wet, and had great difficulty in finding a spot on the ice dry enough to pitch the tent. On the 22d we had to pitch it in the wet snow, where the feet immediately became saturated on putting them outside the India-rubber mattresses. A little later on in the year, when the surface of the snow is again covered with ice, or earlier, before the thaw sets in, the surface would no doubt be excellent to journey on.

When we, therefore, on July 21, were compelled to pitch the tent in wet snow, as no dry spot could be discovered, and it was impossible to drag the sledges farther, I sent the Lapp, Lars Tuorda, forward on 'skidor' to find a dry road. He came back, and stated that the ice everywhere was covered with water and snow. For the first time in his life he was at a loss what to suggest. It being utterly impossible to get the sledges farther, I had no choice. I decided to turn back.

I wished, however, to let the Lapps go forward some distance to the east to see the country as far as possible. At first I considered it advisable to let their journey only last twenty-four hours; but as both Anders and Lars insisted that they were most eager to find the 'Promised Land,' and said they could do nothing towards discovering it in that short period, I granted them leave to run eastwards for four days and nights, and then return.

On leaving, I gave them the following written orders:—

"Instructions for Lars and Anders's 'skid' run on the inland ice of Greenland; viz.,—

"Lars and Anders have orders to proceed on skidor eastwards, but are allowed to alter the course, if they may deem it advisable, to north or south.

"At the end of every third mile the barometer shall be read, and the direction run noted.

"The absence is to be four days, but we will wait for six days. After that, viz., on the morning of July 28, we return. If not returned, we leave behind, in a sledge, provisions, brandy, mattresses, etc.

"Lars is warned not to be too bold. Should land be reached, you are to collect as much as you may gather of blossoms and grass; if possible, several kinds (specimens) of each.

"Given on the inland ice in Greenland, July 21, 1883. A. E. Nordenskiöld."

They were allowed to select what provisions, etc., they desired, and were furnished with two compasses, aneroid barometers, and a watch.

At 2.30 A.M. on July 22 they started. The days we waited for them were generally spent in the tent, as water surrounded us everywhere. The sky was covered with a thin veil of clouds, through which the sun shone warmly, at times even scorchingly. From time to time this veil of clouds, or haze, descended to the surface of the ice, and hid the view over the expanse; but it was, remarkably enough, not wet, but *dry*,—yes, so dry that our wet clothes absolutely dried in it. We have therefore, I consider, witnessed a

phenomenon on the inland ice of Greenland which is related to the 'sun-smoke' phenomenon of Scandinavia; viz., what Arago has described under the name 'brouillard sec.'

On the 24th, after an absence of fifty-seven hours, the Lapps returned. It was the want of drinking-water and fuel which compelled them to return. The surface had been excellent for their journey, and they had covered a distance out and back of two hundred and thirty kilometres, — an estimate which I consider perfectly reliable. During the march forward the barometer was read every third hour. It gave the point of return a height of two thousand metres.[1]

As to the run, Lars rendered the following report. When they had reached thirty miles from the camp, no more water could be found. Farther on, the ice became perfectly smooth. The thermometer registered —5° C. It was very easy to proceed on the 'skidor.' At the point of return the snow was level, and packed by the wind. There was no trace of land. They only saw before them a smooth ice, covered by fine and hard snow. The composition of the surface was this: first four feet of loose snow, then granular ice, and at last an open space large enough to hold an outstretched hand. It was surrounded by angular bits of ice (crystals). The inland ice was formed in terraces, thus: first a hill, then a level, again another hill; and so on. The Lapps had slept for four hours, from twelve midnight on July 23, in a hollow dug in the snow while a terrific storm blew. They had till then been awake for fifty-three hours. On the first day there was no wind; but next day it came from the south, and lasted thus until twenty-four miles on the return-journey, when it changed to west. On the return-journey, when forty miles from our camp, two ravens were seen. They came from the north, and returned in the same direction. The Lapps had for a moment lost the track of the 'skidor' in the snow. The ravens flew at first, they found, parallel with the track, and then turned to the north.

On July 25 we began the return-journey. It was high time, as the weather now became very bad; and it was with great difficulty we proceeded in the hazy air between the number of crevasses. The cold, after the sun sank below the horizon at night, also became very great; and on the morning of July 27 the glass fell to —11° C.

As to the return-journey, I may be very brief. The rivers now impeded us but little, as they were to a great extent dried up. The ice-knolls had decreased considerably in size too, and lay more apart; but the glacial crevasses had greatly expanded, and were more dangerous, being covered with snow. Even the cavities and the glacial wells, of which many undoubtedly leave a veritable testimony of their existence behind them in the shape of corresponding hollows in the rock beneath, had expanded, and increased in number. On a few occasions on the return-journey we saw flocks of birds, most probably water-fowl, which were returning from the north.

[1] I have as yet been unable to verify the barometer calculations, and the figures stated here may suffer some modification.

On July 31 we again sighted land, which was reached on the afternoon of Aug. 4, and proceeded to Sophia harbor, where Eskimos were, as arranged, waiting for us. For convenience' sake I now divided our party into two, one of which sailed in the lifeboat of the Sophia to Egedesminde, where the steamer was to take us on board; and the other, in which was myself, marched to that place across the low but broad promontory which separates Tessiusarsoak and South-East Bay, and then in two Eskimo 'kone' boats to Ikamiut and Egedesminde.

On Aug. 16 the Sophia arrived from the north, embarked us, and made for Ivigtut, where we arrived on the 19th.

Of the expedition carried out under Dr. Nathorst during my absence, he will himself make a report,[1] and I have no doubt that the results of the same will prove very important. Particularly will the very rich collections of fossil plants, which he has made with the greatest regard to the geological condition of the strata, be of great value to science, as they will furnish us with many new materials, and detailed illustrations of the flora of the far north during the epoch when forests of fig-trees, cycadi, gingko, magnolia, and tulip trees covered these regions. Dr. Forsstrand and Herr Kolthoff's collections and studies of the fauna of Greenland will also contribute to extend our knowledge of the naturalistic conditions of the arctic regions; while the careful researches made by Herr Hamberg, of the saltness, composition, and temperature of the sea, will, I am sure, greatly benefit hydrography. His researches have been effected in Davis Strait and Baffin's Bay too, the hydrographical conditions of which are but little known.

With regard to the results of my exploration of the inland ice, I may be permitted to say a few words. That we found no ice-free land in the interior, or that it does not exist between 68° and 69° latitude in Greenland, is due directly to the orographical conditions which exist in this part of the country, as referred to in my programme of the expedition.[2] The land has here the form of a round loaf of bread, with sides which gradually and symmetrically slope down to the sea; i.e., exactly the shape which I then pointed out was a necessary condition if the entire country should be covered with a continuous sheet of ice.

But, thanks to the Lapps, my expedition is the first which has penetrated into the very heart of the enormous Greenland continent, and which has thus solved a problem of the greatest geographical and scientific importance. It is the first exploration of the hitherto unknown interior of Greenland, the only continent in the world into which man had not penetrated.

A new means of locomotion, the 'skidor,' seems also to have been acquired for the arctic explorer of the future, which may greatly assist him in his work, and enable him to reach places hitherto deemed impossible of approach, but of the use of which the Lapp seems to possess, so to speak, the monopoly.

A. E. NORDENSKIÖLD.

[1] *Nature*, vol. xxviii. p. 541.
[2] *Ibid.*, p. 37.

LETTERS TO THE EDITOR.

Osteology of the cormorant.

I WOULD make a couple of corrections to the article on the osteology of the cormorant in SCIENCE for Nov. 16.

First, the occipital style is figured as pointing upwards and backwards, and is spoken of as figured *in situ* for the first time. Having made several dissections of cormorants in past years, I would suggest that the bone is the ossified tendon of some of the extensor muscles of the neck, and that it points backwards, and, if any thing, downwards, as figured by Selenka (Bronn's Thierreichs, Vögel, figs. 5, 6, pl. viii.). As drawn in SCIENCE, it would project through the skin of the nape.

Secondly, the patella is spoken of as very large and as throwing "some light on such birds as Colymbus and Podiceps, where this bone becomes anchylosed with the tibia in the adult:" and Professor Owen is referred to as authorizing this statement. Now, Professor Owen describes the patella as 'co-existing with the long rotular process in the loon' (Comp. anat., ii. 83), and figures it as distinct from the process in fig. 34, *l*. In fact, the rotular process was regarded as the anchylosed patella until the time of Nitzsch. This celebrated ornithologist pointed out the co-existence of an enormous patella and rotular process in Podiceps, and showed the true nature of the process ('Osteogr. beitr. zur nat. der vögel,' Leipzig, 1811, pp. 98-101, pl. ii., figs. 13, 14). In fact, the rotular process of the divers is exactly the same in nature as in other birds, differs only in size, and in no wise represents the *co-existing* patella. In position and function the rotular process resembles the olecranon.

J. AMORY JEFFRIES.

Sense of direction.

Professor Newcomb's paper in SCIENCE of Oct. 26 opens an exceedingly interesting, if not a very important subject. It has exacted of me a good deal of thought, and this capricious sense has been a source of no little annoyance. I should like to give a little of my experience. With me the co-ordinates almost invariably revolve 180°. When a boy, I studied geography, and when at recitation sat with my face to the north. I thus had the whole world mapped out in my mind to correspond with my proper sense of the directions. Soon after this, my father moved to a new home; and there I found, to my great annoyance, that my co-ordinates had revolved 180°. My geography was in the greatest confusion. When I began to travel, I found that the co-ordinates would change in the most unexpected manner, first one way, and then the other. I could not trust my sense of direction.

When I came to Lebanon, I found myself with my original boyhood co-ordinates. I graduated, and went back to Arkansas. Upon my return to Lebanon a few months afterwards, the directions had revolved 180°, and I found myself practically in a new town. I had to learn it all over again; and to-day, if I desire to point to the north, my hand instinctively moves towards the south. In travelling I have found it useful to trust as little as possible to the sense, and be guided by the map. In an extended tour through Europe, I was in the habit of preparing myself, before entering each city, by a careful study of its map, — noting the position of the railway-station, direction of the streets, etc. In this manner I was enabled to control the sense of direction. In only one or two instances did I fail to keep the directions right.

I make two practical suggestions: —

1. Students in geography should always sit with their faces to the north.
2. Travellers should prepare themselves, before entering a new place, by a previous subjective arrangement of the directions they are to find there.

J. I. D. HINDS.

Cumberland university, Lebanon, Tenn.

Synchronism of geological formations.

In SCIENCE of Nov. 16, weekly summary, under above heading, Professor A. Heilprin is reported as having called attention to two conclusions of Huxley's on this subject, and to have maintained, that while the first-mentioned conclusion could be logically disproved, and the second derived no confirmation from the supposed facts, the opinion of the older geologists, that geological contemporaneity is equivalent to chronological synchronism, was therefore probably correct.

Professor Huxley, in his presidential address to the Geological society for 1862, supported the conclusions called in question by reasoning, which, so far as I know, has yet to be shown to be illogical. Neither am I aware, that, during the twenty-one years which have since elapsed, geological or paleontological research has tended otherwise than to maintain the logical basis on which he then rested.

If Professor Heilprin will but do what he is reported to claim can be done, he will earn the gratitude of all other geological students by helping to settle what has proved a vexatious question for the past half-century.

E. NUGENT.

Pottstown, Nov. 22, 1883.

From superstition to humbug.

Your editorial in the Nov. 16 issue of SCIENCE might very appropriately have contained an account of the 'magnetic springs' which underlie this portion of the state of Ohio. From my residence three of these springs may be seen, at one of which a large bath-house has already been erected, where, during the present season, an average of forty patients daily tested the curative effects of the waters. These springs are found along the bank of a small creek and at the base of a valley, perhaps twenty-five feet in depth. The water, which contains less than a sixth of one per cent of iron, is brought to the surface of the ground through an *iron* gas-pipe, and "becomes so highly charged with magnetism that it will impart its properties to a knife-blade." The village of Magnetic Springs, a few miles distant, has several large hotels, all of which are so crowded with guests, that rooms must be engaged weeks in advance. Change of residence, rest, and good nursing have together effected a number of cures, all of which, of course, are ascribed to the magnetic properties of the water. Many of the guests return to their home as disappointed as the little girl, who, after drinking a glass of the water, said, 'I do not feel one particle magnified, and I think these springs are a humbug.'

E. T. NELSON.

Delaware, O., Nov. 22, 1883.

Primitive visual organs.

The notice of Dr. Sharp's communication made before the Academy of natural sciences of Philadelphia, in No. 42 of SCIENCE [397], on the habits and on the peculiar visual organs of Solen ensis and S. vagina, between and at the base of the short tentacular processes along the external edge of the distal part of the siphons of these animals, reminds me that I have observed similar habits in other marine animals, and that possibly we may infer that similar

visual cells exist in these cases. I now call to mind the cases of Ostrea and Serpula. When the former has its purplish tentacles extruded from between its valves, and the latter its crown of cirri extended from its tube, if the hand is made to move rapidly over the water in the aquarium in a strong light, so as to cast a shadow upon these organs, both these animals appear to be sensitive to the movement, and independent of any jars or vibrations. The oyster, under these circumstances, at once retracts its sensitive mantle-border; the worms, their cirri.

Upon examining the end of the siphon of Mya arenaria, lines of pigment are found about the bases of both the inner and outer circlets of tentacles, and the upper end of the siphon is pigmented for about an inch, both inside and outside. On the outside, however, there are scattered low, minute, pigmented papillae just under the epidermis and in the pigmented layer or true skin covering the siphon. The questions now arise, What is the nature of these organs? and do not the habits of Ostrea, as above described, justify us in expecting to find rudimentary end-organs on the mantles and siphons of mollusks, answering the purpose of eyes, as appears to be the case in the instance of Solen? Mya, like Solen, in life has normally the end only of the siphon exposed: and visual powers, developed to a certain degree, would therefore be useful to the animal; for, when the siphon is extended above the level of the sand, there are several fishes with mouths and teeth well suited to nip it off, and which would doubtless actually take advantage of the helpless clam, if it could not appreciate their approach.

I find fishes much more sensitive to sudden vibrations established in the water in which they live than to shrill or grave sounds made in the surrounding air near by. This may be due to special powers of perception which they may possess on account of the development of the singular end-organs of the lateral line.

The study of dermal, terminal nerve-endings, modified as more or less specialized sensory apparatuses throughout the different groups of the animal kingdom, is bound to yield many important results in the near future, in addition to what is already known; and the writer is glad that the matter has been taken up by such competent hands. JOHN A. RYDER.

Nov. 27, 1883.

Probable occurrence of the Taconian system in Cuba.

Last year, while making two excursions across the mountains of eastern Cuba, between Baracoa and the southern coast, I had an opportunity to make some observations on the geological structure of these mountains. The rocks composing this end of Cuba fall naturally into three distinct groups, as follows: 1. Ancient, and for the most part coarsely crystalline, basic eruptive rocks; 2. Older stratified rocks, slates, schists, and limestones; 3. The post-tertiary limestones or elevated coral-reefs.

The eruptive rocks form the main mass of the mountains at most points. They appear on the shore in some places, and seem to be almost the only rocks found at greater distances than five or ten miles from the coast. The older stratified rocks occur principally in two irregular belts running parallel with the coasts, and lying one on either side of the great eruptive belt: hence they are found mainly on the flanks of the mountains. The stratified rocks, especially along their contact with the eruptives, are penetrated by numerous irregular masses and dikes of the latter. But that they are all older than all the eruptives is improbable, since the eruptives are themselves evidently of several distinct ages.

So far as I have observed, the stratified rocks are all alike unfossiliferous; and in consequence the precise determination of their stratigraphic positions is a difficult problem. I am satisfied, however, that some of them are widely separated in time. The newer beds, consisting chiefly of fissile slates, soft sandstones, and impure earthy limestones, are probably equivalent to the secondary and tertiary strata of San Domingo and Jamaica. These uncrystalline sediments occur chiefly on the northern slope of the mountains, and, although much disturbed and undulating, rarely exhibit high dips.

But on the south side of the dividing-ridge, or summit, I crossed a belt six to eight miles wide, reaching almost to the coast, of highly inclined crystalline schists. The stratification is usually distinct, the strike being parallel with the coast, or east-west. The schists are generally greenish, and are both hydromicaceous and chloritic. Associated with the schists are several immense beds of white crystalline limestone. The limestone undoubtedly belongs to the same series as the schists, and is often micaceous.

These rocks bear a strong resemblance to the Taconian system of western New England, and are essentially identical with the great series of semi-crystalline schists and limestones of Trinidad and the Spanish Main which I have elsewhere correlated with the Taconian.

The published reports on the geology of San Domingo and Jamaica show that the geologic structure of those islands is essentially similar to that of eastern Cuba. In each case there is a prominent axis of old eruptive rocks, flanked on either side by schists, slates, limestones, and other sedimentary formations, and by elevated coral-reefs. In San Domingo and Jamaica the eruptives are not wholly basic, but much granite occurs; and the metamorphic schists, which appear to be similar to those of Cuba, have been generally confounded with the cretaceous beds. I predict, however, that more careful study will show that they are distinct and vastly older, and that the Greater Antilles are similar in composition and structure to the southern coast of the Caribbean Sea, including the Spanish Main and Trinidad, except that the coral-reefs and the eruptive rocks are wanting in the latter region. We owe the coral-reefs largely to the great vertical movements of the Greater Antilles in recent times; and the eruptive rocks are but a continuation westward, and the older and more eroded portion, of the great Caribbee belt of volcanic rocks which begins a hundred miles north of Trinidad, and ends in Cuba, being about fifteen hundred miles long.

W. O. CROSBY.

THE RESTORATION OF ANCIENT TEMPLES.

The Parthenon: an essay on the mode by which light was introduced into Greek and Roman temples. By JAMES FERGUSSON, C.I.E., D.C.L., LL.D., etc. London, *Murray*, 1883. 8+135 p., 60 illustr., 4 pl. 4°.

ONLY a small portion of this book is devoted to the wonderful edifice from which it is named. It is in the main a reiteration of peculiar views concerning the lighting of ancient temples, — an amplification of theories advocated thirty-

four years ago by Mr. Fergusson, in his 'True principles of beauty in art.' In a preface to the present volume, the author states his conviction that it is certain to prove offensive to specialists 'from the novelty of the views advanced;' but as these views are almost exactly those adopted in his earlier publication, and as this application of a clere-story to ancient temples can hardly be called original, — it having been suggested by Boetticher in 1847, two years before its first mention by Mr. Fergusson, — it would seem more natural to seek for some other explanation for the discontent of the critics.

It is certainly true, that more has been written, and more angry controversies have arisen, regarding the hypaethron, than with reference to any other feature, either constructive or artistic, in the temples of the Greeks; and after careful study the conviction forces itself upon the reluctant mind, that this last contribution, surpassing in extent and elaboration all others, does little toward the confirmation of that hypothesis in any of its varieties.

Mr. Fergusson adopts for the Parthenon, the temple of Zeus and that of Hera at Olympia, the temples of Aegina, Paestum, Selinous, — in short, for all regular Greek peristyles, — a clere-story sunk by two long openings in the roof at either side of the ridge, which remains unbroken over the central aisle of the naos. The height between the entablature of the upper order of interior columns and the inclined lines of the roof is that of his vertical windows. The drainage from this imperfect covering is effected by perforating the lateral walls of the cella with gutters, leading the rain-water into the pteroma, in which ceiled and protected colonnade such dripping must have been particularly undesirable. Contrary to the fundamental separation of roof and ceiling universally carried out in Greek architecture, he leaves the central aisle open to the inclined roof-surface, like the Bavarian Walhalla, and defends this feature with the surprising statement that flat ceilings, in either wood or plaster, were unknown in classical times. The argument adduced to prove this inclination of the ceiling, visible from within, is found by Mr. Fergusson in the well-known complaint of Strabo (viii. 3, 30, p. 353), — that the statue of Zeus at Olympia was so large, that, if the seated deity should arise, the roof of the building would be carried away. This passage is certainly not "the only hint in any ancient author as to how the roofs of Greek temples were constructed," and, what is worse, its application to the point in question is dependent upon a mistranslation. The words of Strabo, 'almost touching the ceiling with *the top of its head*,' are wrongly rendered by Mr. Fergusson, 'nearly touched *the summit of the roof*.' This misleading version is twice given in the present volume (pp. 2 and 111), and from it the non-horizontal form of the ceiling is directly deduced. It seems high time that this blunder, repeated by so many writers since its first commission by Quatremère de Quincy, should at last be eliminated from discussions of the subject.

As it would naturally have been impossible to surmount with a clere-story those smaller peripteral temples which were without columns in the naos, Mr. Fergusson is obliged to assume, against all evidence, that interior pillars or pilasters did originally exist, and that, while the Christian reconstruction of the Theseion obliterated the traces of these in that building, a figured mosaic pavement in the remarkably similar temple of Assos should be taken to indicate the position of such supports. The last example is certainly not favorable to the theory; for the bedding of the pavement in question is distinctly shown, by plan and text of the first report on the investigations at Assos,[1] to have extended to the very edge of the lateral walls, thus precluding the possibility of any columns or piers within the narrow hall.

The omission of galleries from interiors, which were provided with a double range of columns standing at some distance from the wall, is even less excusable. The assertion (pp. 8 and 73) that there were no galleries in the temple of Aegina is unwarranted. The only reason advanced for this, that the space between the shafts and the wall was only about one metre in width, is of no weight. To suppose that one order of columns was balanced upon another, with an intermediate entablature not tied to the wall by a floor, is unworthy our conception of the constructive wisdom displayed in Greek architecture. These galleries, known from literary sources to have existed in many temples, were actually found and measured at Paestum; and yet Mr. Fergusson omits them entirely from his section of that monument, without a word of justification (fig. 41). The notched architrave from the same site, in which he sees 'the most direct proof of the theory,' 'final in its correctness,' has really no bearing upon the question, being simply an example of the commonest method of construction, when adjoining horizontal ceilings were employed on different levels. This appears constantly in every kind of Greek buildings.

In one instance, however, the author must

[1] Rep. arch. Inst. Amer.

be admitted to have proved his case. The plan and interior arrangement of the temple of Bassae — which is in so many ways exceptional among buildings of its class — certainly point to some system of lighting by vertical windows above the interior ranges of pilasters. The curious position of these buttresses, which are awkwardly spaced so as to stand in the axes of the intercolumniations of the side colonnade, and especially the discovery of perforated tiles on the site, make it more than probable that this remarkably archaistic temple displays an intentional reversion to the manner of lighting the primitive, non-peripteral cella through open metopes. It is to be observed that the statue of the deity was not placed in the space thus lighted, which seems to have been considered as a sort of inner vestibule before the Holy of holies, — a hall decorated, like the exterior of the Parthenon, with a carved zophoros, intended to be seen by the general public. Mr. Fergusson is probably at fault in supposing the image at Bassae to have been a mere *simulacrum*, which had become sacred among the rude inhabitants of the mountain from some accidental cause. He gives no reason for such a belief, and of no temple of antiquity is the story of the dedication so well known. The deliverance of the Arcadians by Apollo Epikourios, from a prevalent pestilence toward the end of the fifth century, does not admit the assumption of a rude symbol, or even of a xoanon, within his fane.

The explanation of the roof-opening of the little cella upon Mount Ocha is good, as is also the concise treatment of the corrupt text of Vitruvius. The importance of both these points has certainly been greatly overrated by previous writers upon the subject. Mr. Fergusson advocates the change of *octastylos* to *decastylos*, and *et* to *est*, in the confused description of the Roman builder; and this appears plausible in view of the acknowledged corruption of the manuscripts, and the fact that the temple of Olympian Zeus at Athens, thus alone referred to, was the only building in Europe possessing all the peculiarities described. Having been without a roof at the time Vitruvius wrote, it certainly was *sub divo* and *sine tecto*, as he says. Mr. Fergusson's restoration of this temple is ingenious; but as it is not known that the structure was ever completed at all, and as even its plan is not yet ascertained, the attempt to delineate its roof is hardly of greater value than that dissertation 'on the use of the particle δέ in the lost plays of Menander,' which a German scholar is wickedly reported to have written. And what are we to think of the disquisition on the Chaitya temple of Karlé, dragged in to lend weight to this restoration? That excavation in the native rock is lighted by a great window at the front, as it of course only can be: and yet in this feature Mr. Fergusson sees the direct influence of Greek and Roman architecture, felt after the incursion of Alexander into India, and the establishment of the Bactrian kingdom; making the system of illumination employed for the cave an imitation of that in the temple of Zeus at Athens by the argument that the appearance of light-openings on one side only must have been foreign to the wooden structures from which the Chaitya caves were in detail more or less imitated. Surely insistence upon precedent could be carried no farther.

The author's restorations of other temples are interesting, but hardly less improbable; the complicated makeshifts to which he is driven, by his various systems of windows in light-shafts, being too remote from the simple and straightforward methods of ancient building to please our imagination, or satisfy our practical sense of constructive fitness. A detailed consideration of all the temples treated of would here lead to undue length.

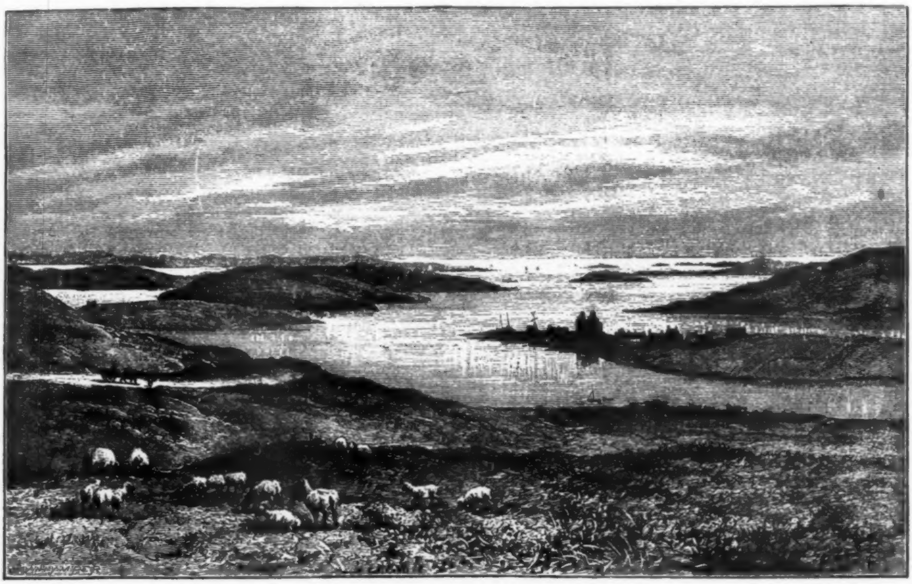
The account of the derivation and timbered prototype of the Doric style is inadequate; and the attempt to rehabilitate Falkener's proto-Doric capital unreasonable, after the well-known proof by Bergau and Erbkam of its wrong combination out of fragments of Egyptian bases. Incorrect, also, is the reiterated statement, that no Doric temples were built after the age of Alexander the Great. In certain parts of the Hellenic world other styles were but exceptionally employed, even in the latest epoch; as we know, for instance, from the ruins of Pergamon, where there is a complete Doric peripteros (that of Athena Polias), which certainly was constructed under the dynasty of the Attalidae. The comparison of the development of temple-architecture among the Greeks with Catholic church-building during the middle ages and during the reign of Queen Anne is misleading. Style among the ancients depended rather on geographical, or, to speak more correctly, on ethnographical, distribution than on passing fashions.

The description of the Parthenon is as thorough as any review antedating the recent investigations of Doerpfeld, which may not have been available at the time of writing. A model of the building, constructed by Mr. Fergusson on a generous scale, one-fortieth of real size, must be extremely interesting. Too much can-

not be said in recognition of this interest in a branch of science not over-popular in these days, which has led the author to an expense of time and money hardly likely to be appreciated. Still, it is to be regretted that the chief attention devoted to this reproduction was evidently directed to an exemplification of an improbable method of lighting. A second gallery is added to the temple, the trenches sunk deeply in the roof being made accessible by stairs; and these *piombi* Mr. Fergusson sets apart for the females of the Athenian congregation, who must have been as uncomfortable there as the most confirmed misogynist of antiquity could have desired. The staircases, by the way, present in the section (pl. 3) a curiously impossible arrangement, approaching from either side as they ascend, so as to intersect at the level of the gallery, and leave no landing-place, — not a good instance of that application of common sense to the study of Greek architecture which Mr. Fergusson so warmly advocates. It has, moreover, been ascertained that the stairs in the Parthenon were situated where they might naturally be expected, — next to the entrance-door, not at the farther end of the naos.

A part of the book sure to be read with great satisfaction by students of archeology is the arraignment of Mr. Wood, the explorer of Ephesos, whose inadequate publications, and selfish hiding-away of the results of his richly endowed work, deserve all the asperity with which Mr. Fergusson treats them (p. 32).

The printing is careful. We notice few minor errors. Lagardette's folio is dated Paris, 1879, instead of 'seventh year of the republic (1799);' while 'M.' Boetticher's essay, published at Potsdam in 1847, is said to be without date.



SCALLOWAY FROM THE NORTH-EAST.

THE ORKNEYS AND SHETLAND.

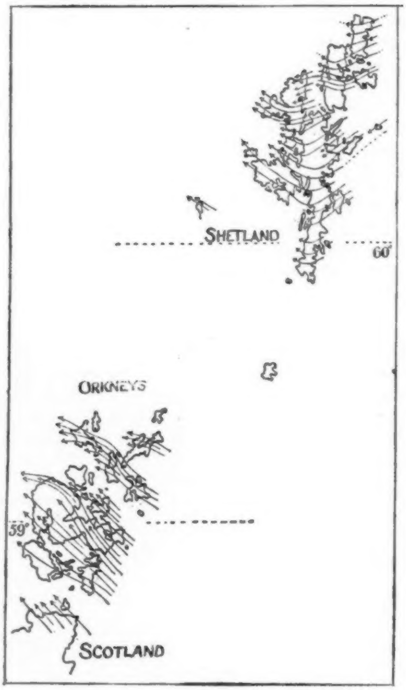
The Orkneys and Shetland; their past and present state. By JOHN R. TUDOR. London, *Stanford*, 1883. 29+703 p., illustr. 8°.

MR. TUDOR has collected and revised a series of letters published under the *nom de plume* of 'Old Wick,' in *The field*, the English sporting-journal, from 1878 to 1880, on the Orkneys and Shetland, and, with contributions from several scientific friends, has prepared a very entertaining book on these out-of-the-way islands. The general reader will find in it an interesting historical essay, embracing the period from Norse occupation to modern times, followed by local descriptions and numerous

maps, that may well serve as a visitor's guide. Primitive old-fashioned ways have endured on these remote islands till recent times, and furnish many anecdotes to enliven the descriptive pages. The more scientific student, with a liking for botany, geology, mineralogy, or archeology, will meet with much worthy of his attention.

The two geological chapters, prepared by Messrs. Peach and Horne from their papers published in the *Quarterly journal* of the geological society and elsewhere, are of chief scientific value, and are well illustrated by neatly colored maps. The southern group is shown to be almost entirely covered by the various divisions of the old red sandstone; and, indeed, this formation once extended over a great area thereabouts, now broken up into ragged islands by dislocation, erosion, and submergence, so that only the smaller part of the original deposit remains. The topographic effect of former erosion at a higher level, followed by depression, is seen in the irregular shore-line and fringe of islands shown in the view of Scalloway. In their present attitude, the islands suffer most along their western coast, where the heavy waves of the Atlantic cut them back into imposing cliffs, such as are found on the western side of Hoy. Shetland includes a considerable variety of old metamorphic rocks, and numerous intrusives and eruptives. The relations of the latter to the adjoining masses is often finely exposed in the sea cliffs, and questions of age are not left to vague inference. Dikes, necks, intrusive sheets, and overflows are all well exhibited. But the geological interest culminates in the glacial question. These northern islands give the key to the movement of the combined Norwegian and Scotch ice-sheets, and show, as was first suggested by Croll, that they joined forces in the basin of the North Sea, and together moved north-westward, out into the Atlantic. The striae are of two dates. The later ones depend on the local topography for their direction, and are referred to a 'later glaciation,' though it is not shown that a non-glacial interval separated this from the greater or primary glaciation, during which the ice moved independently of local topography, over-riding all the hills and ridges. Only these are shown on the accompanying outline, which is traced and reduced from two maps of much larger scale in the original. On the Orkneys the scratches run north-west with much regularity. Marine shells and rocks derived from eastern Scotland are found in the bowlder-clay. On Shetland the approach of the ice was from the north-east,

RORAY HEAD AND THE OLD MAN OF HOY DURING A WESTERLY GALE.



COURSE OF GLACIAL SCRATCHES.

but the motion changed to north-west about the middle line of the group. The great variety of rocks in north and south strips gives abundant opportunity for determining this motion by the direction of dispersion of the bowlders from their parent ledges. No Scottish bowlders are found here, nor do marine remains occur in the drift. Raised beaches do not appear on any of the islands. It is concluded that Scandinavian ice covered Shetland, while Scottish ice advanced over the Orkneys; the original motion of both glacial sheets being changed where they coalesced, in the shallow North Sea, and turned to the line of least resistance, — north-west to the open ocean. There they must have ended in a great ice-cliff like that discovered by Ross in the Antarctic Ocean. It may be well to refer here to Helland's study of the Faroes a few years ago, when he showed that they bear no marks of continental glaciation, the few scratches he found there depending on local form for their guidance.

Our space forbids mention of the many other interesting topics that Mr. Tudor's book discusses, although few volumes contain so many pages of entertainment to the general reader; but attention should be called to the well-considered character of the work, only seldom marred by a remnant of newspaper style. In its table of contents, illustrations, glossary, bibliography, and index, the volume is all that can be desired.

WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.

MATHEMATICS.

Partial differential equations. — M. Darboux considers an arbitrary partial differential equation, defining a function, z, of any number of variables. Replacing z by $z + ez'$, developing according to powers of e, and equating to zero the coefficient of e, a new equation is formed, which the author calls the auxiliary equation. The auxiliary equation defines solutions differing infinitely little from a given solution; and so it has a signification which does not depend on the choice of variables, and which will remain unchanged by any arbitrary change of the variables. The equation, being linear, is easy to deal with, and conducts to many important results which are intimately connected with the given equation. The author considers especially two geometrical problems. First: having given a surface, Σ, attempt to find all the infinitely near surfaces which will form with Σ one family of a triply orthogonal system. This problem, which has already been studied by Prof. Cayley, is equivalent to either of the following problems: 1°, To find all surfaces admitting of the same spherical representation as Σ; or, 2°, To find all the systems of circles normal to the family of surfaces of which Σ is one. It follows at once, that, if the problem of the spherical representation of Σ is solved, the solution can be at once arrived at for the inverse surfaces to Σ, or the surfaces arrived at by the transformation by reciprocal radii.

The second problem considered by M. Darboux is one famed for its extreme difficulty; viz., to find the surfaces applicable to a given surface. Denote by δx, δy, δz, the increments taken by x, y, z, in passing from a point of the given surface, Σ, to the corresponding point on an infinitely near surface: then, expressing the necessary condition to the solution of the problem, — viz., that the small arc shall not change its length, — we have —

$$dx\, d\,.\,\delta x + dy\, d\,.\,\delta y + dz\, d\,.\,\delta z = 0.$$

Replacing δx, etc., by proportional quantities, — say, x_1, y_1, z_1, — this is $dx\,dx_1 + dy\,dy_1 + dz\,dz_1 = 0$; i.e., the corresponding elements on the surfaces Σ and Σ_1 are orthogonal. M. Darboux's problem is thus conducted back to a problem solved by M. Moutard. The

surfaces for which the problem can be solved are divided into certain *classes*. M. Darboux gives the expressions for the co-ordinates of a point in terms of two parameters for the surfaces of the first class. — (*Comptes rendus*, March 19.) T. C. [441

ENGINEERING.

Theory of the screw-propeller. — Mr. J. N. Warrington, of the Stevens institute of technology, discusses the theory of the screw-propeller, and the methods of designing it. He first discusses the action of the screw in the water, investigates the conditions of maximum efficiency, and obtains expressions for the efficiency in terms of the angle of the blades, and the ratios of resistance of friction to pressures exerted. He finds, as does Froude, that the angle of maximum efficiency is forty-five degrees. It is found that a small amount of slip does not necessarily give good performance, — a conclusion already proven by experience. It is found that the action of the screw, in its most efficient operation, does not involve the sternward projection of a solid stream; and hence it follows that all investigations based, as is common, on that assumption, are inaccurate. Yet it is only the water that is thrown aft that gives propelling-power, and the nearer the stream is solid, the better. He obtains the equation of the curve of the developed screw from Thurston, and expressions for the magnitudes of diameter and thrust from Seaton. The second part of the paper is devoted to the designing of the screw according to the principles deduced in the first part. The shape of a blade upon which the water shall glide without shock, and from which it shall be thrown aft with a given velocity, acquiring that velocity by a uniform acceleration, is given by its equation as deduced by Warrington. The relation between the pressure and the acceleration is ascertained; the slip is assumed, and the total resistance is given; and the required size of screw is calculated. The magnitude of the losses of energy, and the efficiency, are determined, and the process is applied to the guide-blade propeller as well as to the common screw. Two wheels are drawn, — the one a U. S. naval-department screw, the other a screw designed on Warrington's plan. — (*Journ. Frankl. inst.*, Aug.) R. H. T. [442

Light prime motors. — President D. Napoli, of La société de navigation aérienne, in a communication to the *Aéronaute*, compares the weight of steam-engines and electric motors for use in aeronautics. He finds that the weight of fuel and water demanded by a steam-engine of twenty-horse power for ten hours' work would be not far from 1,600 kilos (3,527 lbs.), while the weight of an electric motor and its supplies would be about 1,400 kilos (3,087 lbs.); giving a decided advantage to the latter aside from the weight of the engine, which may be anywhere from two hundred and fifty to four hundred per cent greater than the weight of its supplies, according to style, which M. Napoli does not prescribe. — (*Chron. ind.*, June.) R. H. T. [443

Resistance of railway-trains. — Professor Franck has written a memoir on the resistance of trains, studying the earlier experiments of Vuillemin, Guebhard and Dieudonne, and of Rockl. He obtains the formula for resistance,

$$w = m + \frac{l F v^2}{Q},$$

in which w is the resistance in kilos per ton, Q is the weight in tons, m, l, and F are the coefficients, as follows: —

For passenger-engines . .	$m = 0.0032$
" freight-engines . . .	$m = 0.0038$ to 0.0039
" the cars	$m = 0.0025$
" all cases	$l = 0.1225$
" passenger-engines . .	$F = 7$
" freight-engines . .	$F = 8$
" passenger & box cars,	$F = 0.5$
" unloaded flat cars . .	$F = 0.4$
" loaded flat cars . . .	$F = 1.0$

The author of the paper considers that this formula, used with this assortment of constants, will allow of very exact calculation of the resistance of trains. — (*Mém. soc. ing. civ.*, June.) R. H. T. [444

Dowson's gas for heating. — In 1882 the Messrs. Crossley put in a Dowson plant for making his gas. The trial of the system gave the following results: when the gas was made from Trimsaran anthracite, a gas-engine consumed 1.5 pounds (0.68 kilogram) per hour per horse-power; when using Garnant anthracite, the consumption was 1.4 pounds (0.64 kilogram). These results were so satisfactory that the Messrs. Crossley have adopted the gas-engine throughout their works, and are using some 200-horse power. The engine above referred to was of about 30-horse power. It is found that a larger engine, 40-horse power, uses but 1.2 pounds (0.54 kilogram). The process consists in passing a current of steam and air through a mass of red-hot carbonaceous materials. Coal-gas has nearly four times the heating-power of this gas, but the cost of the Dowson gas is so much less that it compensates this great difference. It is, however, intended to compete with the gas produced from coal-oils. The author of the paper calculates that the costs of operating a steam-engine, and of working a gas-engine driven by his gas, are as three to two, the engines being of 100-horse power each. — (*Proc. inst. civ. eng.*, 1883.) R. H. T. [445

AGRICULTURE.

Reversion of superphosphates in the soil. — Farsky shows, that, when a small quantity of water acts upon a superphosphate, the monocalcic phosphate which it contains is decomposed into dicalcic phosphate and free phosphoric acid. The same process seems to take place when a superphosphate is mixed with the soil. Subsequently the free acid appears to act upon the calcium, iron, and aluminum salts of the soil, forming dicalcic phosphate and soluble acid phosphates of iron and aluminum. The latter are not stable, and soon pass into insoluble combinations (compare SCIENCE, i. **825**). — (*Biedermann's centr.-blatt.*, xii. 450.) H. P. A. [446

Fineness of superphosphates. — Farsky, both in pot-experiments with buckwheat, and in field-experiments with several other crops, found that coarse

superphosphate gave a greater increase than fine. Exactly the opposite result was given by Wagner's experiments, reported in SCIENCE, i. **310**. — (*Biedermann's centr.-blatt.*, xii. 453.) H. P. A. [447

Experiments on the continuous growth of wheat and barley. — These experiments by Voelcker, on the plan of the well-known Rothamsted experiments of Lawes and Gilbert, are in progress at Woburn, on a light soil, and are intended to supplement those at Rothamsted, which are on a heavy clay soil. The present report gives the results of the sixth year, viz., 1882. The most interesting of the results are those obtained on four plots, two of which had received mineral manures and nitrates or ammonia salts, and two stable-manure. Each plot was halved. One half received the same fertilizers as in preceding years; while the other remained unmanured (in case of the stable-manure plots), or received the mineral fertilizers of the preceding year, but no nitrogen. The mineral fertilizers alone gave no larger crop than was obtained from plots unmanured for six years, while the other half of the same plots, which received nitrogen, gave about thrice as large a crop. The evident conclusion was, that the plots were deficient in nitrogen, and that the large amounts of nitrates or ammonia salts, which they had received in previous years, had left no available residue of nitrogen in the soil. In the case of the plots which had received stable-manure, the unmanured halves showed that a portion of the manuring of previous years was still available, though the gain thus caused was small. In all the experiments of this year, sulphate of ammonia produced better results than an equivalent quantity of nitrate of soda. — (*Journ. roy. agric. soc.*, xix. 209.) H. P. A. [448

MINERALOGY.

Cuspidine. — This comparatively new mineral has been crystallographically examined by G. von Rath. It occurs at Vesuvius in very characteristic spear-head-shaped crystals, which are not to be confounded with any other mineral. The crystals were found to be monoclinic, the apparent rhombic form being the result of twinning. The axial relation is $a:b:c=0.7243:1:1.9342$. $\beta=89°\ 22'$. The measurements were made on a single small crystal, which showed no evidence of twinning; the symbols for seventeen different forms being obtained, cleavage parallel to the base, plane of twinning the orthopinnacoid. Sections from the mineral gave the optical properties of monoclinic crystals. Material pure enough for analysis could not be obtained, as the mineral is peculiarly liable to alteration. An analysis by E. Fischer, of impure material, showed that in addition to calcium fluoride the mineral contains the silicate Ca_2SiO_4.

A very few minute crystals of a mineral resembling cuspidine were found at Vesuvius, occurring in orthorhombic prisms, very much striated, parallel to the vertical axis, and terminated by an obtuse pyramid. An approximate axial relation, $a:b:c=0.560:1:0.417$, was obtained; but the material did not admit of further investigation. — (*Zeitschr. kryst.*, viii. 38.) S. L. P. [449

Empholite. — This new mineral has been described by L. J. Igelström as occurring at Hörrsjöberg, Wermland, Sweden; in small, well-formed crystals and fibrous aggregates. The prisms, sometimes attaining a length of six millimetres, are brilliant, and resemble diaspore in form, the prismatic angle being about 123°-130°: with cleavage parallel to the brachypinnacoid; hardness, greater than six; color, white, changing to yellow on exposure, owing to the oxidation of the iron; before the blow-pipe infusible, giving a beautiful blue color with cobalt solution, and, in the closed tube, neutral water; scarcely attacked by acids. Two analyses, after correcting for sixteen per cent of gangue, yielded —

SiO_2	Al_2O_3	$\underbrace{MgO.\ CaO.\ FeO.}$	H_2O	
52.3	30.5	3.4	13.8	= 100
48.8	33.3	3.3	14.6	= 100

The mineral is a hydrous silicate of alumina, and the formula $Al_2Si_2O_7 . 3H_2O$ is proposed; but the analyses are not correct enough to lead to any definite formula. — (*Bull. soc. min.*, vi. 40.) S. L. P. [450

METEOROLOGY.

Barometric maxima and minima. — The meteorological conditions which are characteristic of regions of high and low pressure have been studied by various investigators, notably by Mohn, Clement Ley, and Loomis. The latest contribution to this subject is made by Hildebrandsson, who bases his conclusions upon observations made at Upsala and other stations in northern Europe since 1873. He discusses the angle of the wind with the barometric gradient, the wind velocity, the direction of the upper and lower clouds, the air temperature, the amount of cloudiness and rainfall, the transparency of the air and fog, — all with regard to their relations to areas of maximum and minimum pressure. The conclusions are based wholly upon tabulations of the observations, and are primarily applicable to Upsala and vicinity, but are in general similar to those obtained for other countries. — (*La distr. élém. mét. autour min. et max. bar.*) W. U. [451

ZOÖLOGY.

Animal coloring-matters. — The application of the spectroscope to the determination and discrimination of coloring-matters from living organisms has opened an interesting field of research. Dr. C. A. MacMunn gives an extensive *résumé* of previous work, and the results of his own studies in this field. His article is a valuable presentation of our knowledge of the subject; but it necessarily contains many details, and is therefore unadapted to a brief abstract. The following points deserve special notice. Haematin may be prepared by a new method: "Fresh defibrinated blood is treated with a mixture of two parts of strong sulphuric acid to thirty-five of alcohol, and thrown on a filter, more alcohol being added to help the filtration; the filtrate is diluted with water, put into a separating funnel, and shaken up with chloroform. After standing some time, the chloroform is separated off, and filtered and evaporated. . . . The residue corresponds to haematin as it is usually described." By the action of strong mineral acids on

this haematin, Hoppe-Seyler's haemato-porphyrin was obtained; it is practically identical with Thudicum's cruentin. When neutral dried cruentin is boiled with equal parts of rectified spirit and acetic acid, a five-banded spectrum was obtained, similar to if not identical with that of Preyer's iron-free haematin. Bilirubin is identical with haematoidin. There are several lutein pigments; for example, that of the hen's egg is different from that of the corpus luteum of the cow. Tetronerythrin is very widely spread, occurring in 'the roses' around the eyes of certain birds, in the skin of the red mullet, and in many invertebrates; it is apparently capable of performing respiratory functions, somewhat like haemaglobin. Its presence in the crust of lobsters and crabs is noteworthy. The various classes of invertebrates are taken up in succession, the following being the principal pigments described: chlorophyll, pentacrinin, cruentin (in starfishes), echinochrome, cochineal, aphidein, bonellein, haemocyanin (in blood of Octopus), aplysiopurpurin, dermolutein, etc. Numerous spectra are reproduced in the charts. In an appended note, it is stated that chlorophyll is found in the liver of mollusks: *cf.* Royal society's proceedings, April 5, 1883. — (*Proc. Birmingham nat. hist. soc.*, iii. 351.) C. S. M. [452

Mollusks.

Abyssal mollusks. — Dr. Jeffreys continues his valuable papers on the deep-sea mollusks of the Lightning and Porcupine expeditions. The last instalment includes the Scissurellidae, Trochidae, Turbinidae, and Littorinidae, with two fine plates on which are figured twenty-one new forms. Several new genera are described. Tharsis Jeffreys has a closed umbilicus and appressed peristome, which separate it from Cyclostrema: the type is Oystele romettensis Seguenza. Ganesa is like a very minute, delicate Lunatia, with a perforate axis. Cantrainea is suggested for Turbo peloritanus Cantraine. Hela Jeffreys, beside being pre-occupied, proves to be identical with the Japanese Cithna A. Ad. Iphitus Jeffreys is a minute form, resembling Fossarus or a miniature Tectarius, with a peculiar apex and subspiral operculum. — (*Proc. zoöl. soc. Lond.*, March, 1883.) W. H. D. [453

Further researches on nudibranchs. — Bergh prints an important paper, illustrated by five beautiful anatomical plates, as a supplement to his monograph of the family of which Polycera Cuvier is the typical genus. After a number of general notes on species and genera, among which is the description of Ohola, a new genus collected by the Challenger at Arapura in the South Seas, the author considers the Dorididae in general, with their divisions and probable phylogeny. The genus Heterodoris of Verrill and Emerton is considered as probably belonging to a different family. The Dorididae are separated into two very well marked groups by the possession of a single large retractile crown of gills or of numerous non-retractile branchia, cryptobranchiata, and phanerobranchiata respectively. The latter, connected with the typical Dorididae through Staurodoris, diverge in two lines, of which the more ancient forms are Notodoris and Akiodoris. The former culminates in Plocamophorus, with Ohola as a lateral branchlet. The latter passes through Acanthodoris, Goniodoris, etc., toward Ancula and Drepania.

The phanerobranchiate, non-suctorial Dorididae form the Polyceradae (better Polyceratidae) of Bergh, and the suctorial forms his Goniodorididae. Of these groups a full discussion is made, and a synopsis of their genera and species is given. They inhabit all seas, but are largest and most beautiful in the warmer regions. — (*Verh. zool. bot. ges. Wien*, März, 1883.) W. H. D. [454

Worms.

Development of Phoronis. — A. Foettinger has published an article on this subject in Van Beneden's *Archives de biologie* (iii. 679). He found in the morula stage, that the cavity contained a few spherical or oval corpuscles, sometimes surrounded by a fine granular substance filling the whole segmentation cavity. The important question he deems to be, whether these elements, which are clearly the first rudiments of the mesoderm, are derived from the endo- or the ecto-derm. Kowalevsky is in favor of the latter view, while Metschnikoff holds to their endodermal origin. If the larvae are treated with acetic acid, and immediately examined, evidence will be afforded as to the presence of the first mesodermic elements at a time when the ovum is still segmenting; and, indeed, indications of them were seen in two cases, where the developing ova consisted of only eight blastomeres, for there is in them a central corpuscle which appears to have a mesodermal significance. The author has no distinct opinion as to the origin of this cell, but inclines to doubt the explanation given by Metschnikoff. As to the still earlier stages, it is stated that the fecundated ova are developed outside the body of the parent, but that they remain attached to the branchiae for a certain time. After the appearance of four blastomeres, two divide, and so give rise to a six-celled stage, with two large and four smaller cells. (As to the origin of the mesoderm, compare Hatschek's researches on Sipunculus, to be given shortly in SCIENCE.) — (*Journ. micr. soc. Lond.*, iii. 509.) C. S. M. [455

Nervous system of Hirudinea. — Saint-Loup finds that the arrangements of the nervous system, which were thought to be peculiar to Clepsine, are very common among the Hirudinea. Commencing with Nephelis, he saw in the transparent tissues six capsules on the ventral surface of the ventral ganglia. Similar capsules were observed in Aulastomum and Hirudo. The author detected in all Hirudineae the intermediate or unpaired nerve first described by Brandt in the medicinal leech. Saint-Loup hopes to give a general account of the morphology of the nervous system of the group. — (*Comptes rendus*, xcvi. 1321; *Journ. micr. soc. Lond.*, iii. 509.) C. S. M. [456

Insects.

Classification of the larger groups. — From a study of the relationships of the lower insects, Packard has been led to a new arrangement of all

the larger groups, and proposes the following scheme, in which the names proposed for what he terms super-orders are all new: —

Super-orders.	Orders.	Sub-orders.
Euglossata . . .	Hymenoptera.	
	Lepidoptera.	
	Diptera	Diptera (genuina).
		Aphaniptera.
		Pupipara.
Elytrophora . .	Coleoptera . . .	Coleoptera (genuina).
		Strepsiptera.
Eurhynchota . .	Hemiptera . . .	Homoptera.
		Heteroptera.
		Physapoda.
		Mallophaga.
Phyloptera . .	Neuroptera . . .	Trichoptera.
		Planipennia.
	Pseudoneuroptera .	Odonata.
		Ephemerina.
		Platyptera.
	Orthoptera.	
	Dermatoptera.	
Synaptera . . .	Thysanura . . .	Cinura.
		Symphyla.
		Collembola.

A mere outline is presented in this paper, which is only an abstract of his researches, to be published in full in the forthcoming report of the U. S. entomological commission. — (*Amer. nat.*, Aug.) [457

VERTEBRATES.

The function of body-equilibrium. — The central gray substance of the third ventricle, according to Bechterew's experiments, given in this paper, forms an organ of equilibrium in the same sense as the semicircular canals and the olivary bodies. His investigations were made chiefly upon the dog; although confirmatory experiments upon other animals, birds, and frogs, are given. The method of operating was to trephine a hole through the sphenoid bone at the sella turcica; and then, thrusting a small knife through the hypophysis into the third ventricle, a section could be made of the gray matter in any desired direction. Injury of any portion of the gray substance of the third ventricle was always followed by disturbances of equilibrium, similar, in a general way, to those caused by section of the semicircular canals. The author points out that the disturbances of equilibrium which have been noticed by other observers, after sections made in this region, but which were attributed either to the corpora striata or corpora thalami, were most probably caused by injury to the walls of the third ventricle. To explain how it is that the gray matter of the ventricle is affected by changes in equilibrium, he supposes that the cerebro-spinal liquid, which in this portion of the ventricle lies almost in a closed sac, assumes a rôle similar to that played by the endolymph of the semicircular canals. Changes in position of the body cause changes in pressure of the liquid upon the walls of the ventricle, giving rise to stimuli which act reflexly on the co-ordinating centres in the cerebellum. The preservation of body-equilibrium is brought about, according to Bechterew, by the action of three peripheral equilibrium organs; viz., the semicircular canals, the gray matter of the third ventricle, and the olivary bodies of the medulla. Disturbances of equilibrium cannot act as a stimulus to the olivary bodies by reason of any change in pressure of the cerebro-spinal liquid. The normal stimuli for this centre are found in the skin sensations, and perhaps muscle sensations, which reach the medulla from the spinal cord. Each of these three equilibrium organs, it is interesting to notice, is not only connected with the cerebellum, through which it acts on the muscles, but each is closely related also to one of the higher sense-organs, — the olivary bodies, to the skin; the semicircular canals, to the ear; and the gray matter of the third ventricle, as is shown in detail in the paper, to the eye. The intimate connection existing between the organs of sight and equilibrium is known to all; and this connection depends not so much on the visual sensations as on the position of the eyeballs. Injury to the centre in the third ventricle was always followed by marked changes in the direction of the axes of the eyeballs; and the author advances an ingenious theory to show that any change in the position of the eyeballs will act as a mechanical stimulus to this centre. Taken in conjunction with previous work by the same author, this paper makes an important addition to our knowledge of the much discussed question of body-equilibrium. — (*Pflüger's archiv*, xxxi. 479.) W. H. H. [458

Birds.

Sternum of Notornis. — In this paper Prof. Owen replies to a stricture on his plate of this bone, and makes many valuable remarks on the sternum in general. He distinctly adopts the Lamarckian theory for the loss of the keel, and again calls attention to the heterogeneous nature of the Ratitae. — (*Proc. zoöl. soc.*, 1882, 689.) J. A. J. [459

Pacinian corpuscles of birds. — Mlle. Joséphine Cattani has studied the corpuscles of Herbst in the leg of the fowl. The axis of the corpuscle is constituted by an extension of the nerve-fibre; the extension comprising not only the axis-cylinder, but also the medullary and Schwann's sheaths. At the point of entry the fibre is slightly constricted, and there is a Ranvier's node where the fibre reaches the corpuscle. Within the corpuscle the axis-cylinder becomes ribbon-like; the medullary sheath becomes thinner, and has a nucleus. The mass investing this terminal organ is composed of a web of fibres, with scattered ramified cells having oval nuclei; there are also two rows of cells with round nuclei along the nerve-fibre. The external envelope is a layer of connective tissue with very elongated nuclei. The nerve-fibre ends with a little flask-shaped dilatation, which has a granular matrix in which each fibrilla of the axis-cylinder ends in a little button. The author has also investigated the degeneration of these organs, after cutting the sciatic nerve; but this portion of her work lies rather in the domain of pathology. — (*Arch. ital. biol.*, iii. 326.) C. S. M. [460

Mammals.

The lingual sense-organs of Ornithorhynchus. — E. B. Poulton has continued his researches on the tongue (SCIENCE, i. **523**) by studying that of Ornithorhynchus. The tongue is about two inches long, and has only a small part free. The posterior third forms a large rounded conical protuberance, pointing obliquely forwards, and bearing at its apex two corneous teeth. The anterior division is covered by horny papillae, and has numerous mucous glands. The posterior division is more complicated, bearing various organs on its dorsal surface: viz., numerous filamentous papillae; an arching fold, limiting the tongue behind; a median raphe, which does not reach the tip of the cone; and four gustatory pits, — one pair near together, in front; and one pair behind, widely separated.

The papillae upon the anterior division of the tongue are largest in front, and smaller (and more scale-like) towards the base of the tongue, and also extend over the inferior surface of the basal protuberance. Except a few in front, they are all cornified, pointed, and inclined backwards. In each of the interior of these papillae are lodged from one to four sub-epithelial sensory bulbs; a medullated fibre runs directly to each bulb, and there loses its sheath; while the axis-cylinder is continued into a spindle-shaped body within the bulb, which, for the rest, consists of a series of nucleated lamellar envelopes. Poulton compares these organs with the Pacinian corpuscles, and considers them tactile. The epithelium between the papillae is not cornified: in it are found the pore-like openings of the numerous mucous glands.

The epithelium of the overhanging ventral surface of the posterior protuberance is more specialized, in that four strata can be distinguished in it. Curiously, the outer stratum appears less corneous than that which it immediately overlies. The two teeth at the apex have a very thick corneous layer, which, however, does not cover their tips, but forms a ring around an apical spot of softer epithelium.

The dorsal surface of the protuberance is covered by a simple epithelium, with numerous hair-like papillae similar to those in Perameles (SCIENCE, i. **523**). In all four of the gustatory pits is a ridge projecting from the base, and bearing the taste-bulbs under its surface. In the specimen examined the left posterior pit was (abnormally?) rudimentary. Each bulb lies in a papilla, which penetrates far into the epithelium, which is also pierced by a pore over each bulb. The terminal organ is the axial body (cell?) of the bulb, appended to the end of the nerve-fibre. The surrounding cells are sub-epithelial, and form a sheath around the axial body. This observation confirms the author's theory that the taste-bulbs arose as papillary sub-epithelial structures. The value of this theory was asserted in the abstract of the author's previous paper. Numerous serous glands open around the base of the gustatory ridges. Such glands appear to be very generally associated with the organs of taste. Around the pits are smooth muscles, which (at least, around the mouths of the anterior pair) distinctly form sphincters.

The gustatory ridges of Ornithorhynchus, if they rose to the surface and were shortened, would become like circumvallate papillae; if they remained long and became furrowed, they would resemble the foliate areas of rodents: hence Poulton considers that the ridges represent a primitive form from which both the principal types of elevated gustatory areas in mammals may have been derived. — (*Quart. journ. micr. sc.*, xxiii. 453.) C. S. M. [461

Lymphatic and blood vessels. — Dogiel describes the lymph-vessels of the renal capsule and gall-bladder of the dog. In the renal capsule two layers can be distinguished, the outer of which alone is vascular. Prof. Arnstein, in an appended note, states that the rudimentary homologue of the fatty envelope of other species is included in this outer layer. The lymphatics form a coarse network of large vessels, which are accompanied by blood-vessels, and spun over by a loose network of very fine capillaries, while in the meshes of the lymphatic network is an abundant collection of anastomosing blood-capillaries. Each mesh thus forms a vascular island. By this distribution the lymph-vessels are brought as far as possible from the blood-vessels, — an arrangement which is attained in various ways in other parts, and which is important for the perfect drainage of the tissues.

In the gall-bladder there are three sets of lymphatics, — a net for the mucosa, one for the muscularis, and a third for the serosa externa. These are all described and figured. — (*Arch. mikr. anat.*, xxii. 608.) C. S. M. [462

(*Man.*)

Branchial arches and clefts. — Cadiat publishes an article destined to serve as "an introduction to the history of the formation of the face and its different cavities: of the neck, thorax, pharynx, and lung;" also the peritoneum, pleurae, pericardium, respiratory cavities: and gills of fishes (!) The reporter regrets to have found in the article nothing but redescriptions of the pharyngeal apparatus of the embryo chick. As the facts have been familiar to embryologists for very many years, the object of the publication is not obvious. — (*Robin's journ. anat. physiol.*, xix. 38.) C. S. M. [463

Laws of dentition. — Magitot publishes a somewhat lengthy essay on this subject; but the article hardly contains original matter, and is written from a point of view too exclusively that of the dentist. — (*Robin's journ. anat. physiol.*, xix. 59.) C. S. M. [464

ANTHROPOLOGY.

Ancient Orkney-Islanders. — Dr. J. G. Garson has made a very thorough study of the crania and other remains of the ancient inhabitants of the Orkney Islands. His paper takes up in detail their dwellings, stature, limb-bones, and skulls, the last named with great detail, and expresses his results in elaborate tables. The author comes to the following conclusions: —

It is evident that in this series of skulls we have not a single pure race to deal with, but two distinct races, which have existed at probably three different periods. The first and apparently the ruder race

seems to be the long-headed people, represented by the skulls from Skerrabrae and Saverough. We have next the round-headed race, which probably occupied the country for a considerable time. The time when these races inhabited the islands is quite uncertain. The abundance of deer-horn at Skerrabrae indicates the presence of these animals, which would probably be associated with forests. When the Romans visited the Orkneys, their historians tell us that there were no forests there. Also the absence of metals, and the rude implements, point to a people in the unpolished stone period. Some evidence is also found in the washing-away of the coast. The round-headed race seems to have lived just before or at the beginning of the bronze period. — (*Journ. anthrop. inst.*, **xiii**. 54.) J. W. P. [465

The Jutish type of face. — The peculiarity of the Jutish features consists in the form of the nose and mouth. There is no nasal point or tip, properly so called, as in the Danish, Cymric, and Iberian face, and their inter-crosses; nor is there any approach to the slight bulb which distinguishes the Saxon. The end of the nose is rounded off somewhat sharply, and the septum descends considerably below the line of the nostrils. The lips are less moulded or formed, and resemble the Iberian rather than the Saxon type. The lower lip, more particularly, is thick and deep. Mr. J. Park Harrison has been searching for specimens of the Jutish countenance in Kent, Isle of Wight, and in South Hants. — (*Journ. anthrop. inst.*, xiii. 86.) J. W. P. [466

Egyptian mechanical methods. — Petrie, who is the author of a treatise on ancient metrology, has lately turned his attention to ancient Egyptian processes. Though much labor has been bestowed on the literary remains of Egypt and the description of monuments, little attention has been given to finding out the tools and methods by which their results were reached. The first conclusion to which Mr. Petrie comes, is that the stone-cutting was performed by means of graving-points far harder than the material to be cut. These points were bedded in a basis of bronze; and in boring, the cutting action was not by grinding with a powder, as in a lapidary's wheel, but by graving with a fixed point, as in a planing-machine. From discovering spiral grooves in diorite and granite, at least $\frac{1}{100}$ of an inch in depth, the author supposes that an instrument was used of sufficient hardness to penetrate the material that far at a single turn. In this, however, he was corrected by Mr. Evans. The simplest tool used was a straight bronze saw set with jewels; but there is proof of one circular saw which must have been $6\frac{1}{4}$ inches in diameter. For hollowing the insides of stone objects, the inventive genius of the fourth dynasty exactly anticipated modern devices by adopting tubular drills varying from $\frac{24}{100}$ of an inch in diameter and $\frac{2}{100}$ of an inch in thickness, to 18 inches in diameter. Other drills, not tubular, were used for small holes, one measuring $1\frac{2}{10}$ inches long and $\frac{8}{100}$ of an inch in diameter. But this is surpassed by the Uaupes of South America, who drill holes in rock-crystal by the rotation of a pointed leaf-shoot of plantain, worked with sand and water. The writer of this note has seen, in Porto Rico, stone beads of the hardest material, 2 inches long, bored longitudinally with an orifice $\frac{1}{16}$ of an inch in diameter. The Egyptians understood rotating both the tool and the work. For the finishing of vases, a hook-tool must have been used; but the early Egyptians were familiar, not only with lathes and jewel-turning tools, but with mechanical tool-rests, and sweeping regular arcs in cutting. In addition to the tools mentioned, are to be noticed those for dressing out drilled cores, stone hammering and smoothing, saws with curved blades, mallets, chisels, adzes, and bow-drills. For marking and indicating the plane of the stone, red-ochre paint was used in a variety of ways, well studied out by Mr. Petrie. Rock-excavation, both for saving the stone and for the creation of vaults and chambers, was altogether an affair of drilling. Granite bowlders were utilized in the pyramids, but the best stones were taken from quarries. The method of handling these immense masses is not known. Mr. Petrie concludes with a sensible remark upon the oft-alleged inhumanity of the pyramid and temple builders. To require a man every six years to serve upon the public works, during the season when he could do nothing else, would certainly not be a great hardship. — (*Journ. anthrop. inst.*, xiii. 88.) O. T. M. [467

Navajo mythology. — The Navajos, says Dr. Washington Matthews, speak of five worlds, in four of which our fathers lived ere reaching this. In the first world were the first man, the first woman, and the coyote. In the second world were two other men, the sun and the moon people, and at the four corners were the people of the cardinal points. An amour of the sun with first woman led to the ascent of all to the third world, where they found another race of people living in the mountains. Here coyote stole the children of Tieholtsodi (he who seizes you in the sea), who caused a deluge to cover the earth. The emigrants ascended to the fourth world through the growth of a hollow reed. Here a disturbance arose concerning the relative value of men and women, which resulted in favor of the men. After the lapse of some years they were pursued hither by the giant looking for his cubs, which coyote still concealed. The floods rose, and they were let up into world five by the badger and the locust. The cubs were thrown down to the giant, and the waters subsided. Then came the fitting-up of the world for their abode. At this point of the myth are several very pretty origin-stories about the dry land, the mountains, the sun and moon, the making of climate, etc. Here is one. "On the fifth day the sun arose, climbed to the zenith, and stopped. Coyote said, 'The sun stops because he has not been paid: he demands a human life for every day that he labors.' At length a woman, the wife of a great chief, ceased to breathe, and grew cold. The sun travelled down the western sky, and passed behind the western mountain." There is a similar moon myth. Then follow the confusion of tongues, the making of the stars, the lengthening of the seasons, the forming of snow, the planting of corn. At this juncture, on account of the wickedness of mankind, first woman

made the five great destroyers, — Yeitso, Tsinahale, Delgeth, Tseta-holtsil-tahli, and Binaye. She also took to rear a foundling girl, Estsanatlehi. The latter, impregnated by the sun, brought forth twins, who, by the aid of their father, slay the five great destroyers of mankind. The stories of these Herculean labors is charmingly told, and is full of theories about the causes of familiar things, such as the birds, the shunning of a mother-in-law. The mother of the giants repeopled the world, built pueblos, established the gentes. The giants may still be seen in the waters of the San Juan, and the mother continues to send to the Navajos the snow, the spring thaw, the soft rain, the corn, and the green grass. — (*Amer. antiq.*, v. 207-224.) J. W. P. [468

EARLY INSTITUTIONS.

A history of guilds. — A Mr. Waterford, barrister-at-law, is writing a history of English guilds. He has already described the aims and purposes of the guilds. He has also described their history, and the history of public opinion and legislation regarding them. He is now taking up their geographical distribution in the different counties and towns. Extracts are given from the records. The work promises to be one of interest and value. The history of trade unions is a subject which deserves especial attention in these days. It is a very difficult subject, however, and by no means mastered as yet. Contributions towards its elucidation are therefore very welcome. — (*Antiq. mag.*) D. W. R. [469

The Merovingian grants of immunity. — These grants, a chief source of feudalism, are not considered by M. Fustel de Coulanges to have been confined to ecclesiastics, as is usually assumed. The grants to ecclesiastics were no doubt the most numerous, and the documents are at any rate better preserved; but lay proprietors received precisely the same powers. The essential feature of the grant he regards as the exclusion of the public officials from the territory of the immunity, whether for judicial, fiscal, or military purposes. Exemption from financial burdens was a natural but not necessary nor universal consequence. In this he agrees with Heusler, differing from him, however, in holding that the grantee was absolutely removed from all relation to the public official, the count, and stood only under the king; while Heusler considers that he only became an intermediary between his tenants and the count. The result of these grants was to completely break up the administrative system of the Frank empire by removing great stretches of territory from the authority of the public official, and practically to make the proprietor an irresponsible master over his free tenants as well as his serfs. The same effects followed the grants of *mundiburdium*, or protection, by which the proprietor entered into a purely personal relation to the king, ceasing to be under the authority of the count. This substitution of a personal relation for the political one of subject and ruler is also of the essence of feudalism. It is not possible to decide whether the grants of immunity or those of *mundiburdium* were the earlier. Immunity, however, applying primarily to the land, necessarily included the personal relation; while *mundiburdium*, by an equal necessity, led to immunity. The article is written in the interesting style and with the characteristic lucidity of the author, and forms a most important contribution to the study of the origin of feudalism. — (*Rev. hist.*, July - October.) W. F. A. [470

NOTES AND NEWS.

A CABLE despatch was received Nov. 30, at Harvard college observatory, announcing the discovery of a small planet by Palisa at Vienna. Its position Nov. 28, 13 h. 20 m., Greenwich time, was, right ascension, 3 h. 19 m. 14 s.; declination, north, 15° 52′ 17″; daily motion in right ascension, — 48″; in declination, nothing. It is of the twelfth magnitude. The planet was readily identified at Harvard college observatory, and was observed by Mr. Wendell as follows: Nov. 30, 9 h. 30 m., Cambridge time; right ascension, 3 h. 17 m. 27 s.; declination, north, 15° 51.1′.

— While the revenue steamer Corwin was cruising on the coast of Alaska and in the north-west Arctic Ocean in 1881, Dr. Irving C. Rosse, her medical officer, found leisure to prepare a series of medical and anthropological notes, which have just been published by the Treasury department. The medical notes, although they exhibit the mind of a keen observer, are rather technical than racial: there is a short chapter on medical and surgical subjects, however, p. 25. The author holds that the marks of distinction between the Eskimo and the Chukchi are not very plain. At Kotzebue Sound many of the natives are tall and of a commanding appearance. Uniformity of features, so commonly attributed to the Eskimo, has frequent exceptions; many of the natives exhibiting countenances of Chinese, Jewish, Milesian, or even Mulatto cast. The experiments of strength and agility in rowing, racing, throwing stones, and lifting, given on p. 29, are valuable contributions to anthropometry. The popular notion regarding the great appetite of the Eskimo is one of the current fallacies, according to Dr. Rosse. As to the commercial connection between the two continents, natives cross and recross Bering Strait to-day on the ice and in primitive skin canoes, which have not been improved since the days of prehistoric man. With a view to finding out whether any linguistic affinity existed between the Japanese and the Eskimo, Dr. Rosse caused several Japanese boys employed on the Corwin to talk on numerous occasions to the natives, both on the American and Asiatic coast; but in every instance they were unable to understand the Eskimo, and assured him that they could not detect a single word that bore any resemblance to words in their own language. The language varies greatly from point to point. The interpreter taken at St. Michaels could with difficulty understand the natives of Point Barrow, while at St. Lawrence Island and on the Asiatic side he could understand nothing at all. The author happily likens spoken languages to those species of animals which are still in a plastic condition and are undergoing farther development. The Eskimo tongue

is one of these, and yields with facility to almost any external influence.

Dr. Rosse speaks slightingly and flippantly of philological studies, and holds that the observation of habits in satisfying the demands of nature is a surer guide to racial affinities. The dietetic value of seal, bear, walrus, eider-duck, whale, and reindeer, is discussed; and we are led to believe that the Eskimo are by no means to be pitied for their miserable food. Says Dr. Rosse, "We dined occasionally on fresh trout, young wild duck, and reindeer. . . . There is scarcely any better eating in the way of fish than Coregonus, and certainly no more dainty game than young wild geese and ptarmigan." The cranberries and a kind of kelp are the only vegetable food. Eggs in all states are eagerly devoured, though the women will not take gull's eggs. Game is both plentiful and very tame.

Courtship and marriage are exceedingly simple, parturition is easy, families are small, and mortality among the new-born excessive. The description of the carrying of infants and the plays of children exhibit in the author a genuine sympathy absolutely necessary in an observer of natural history. The personal ornamentations are chiefly tattooing and wearing labrets. The native has no music in his soul, although rare instances of acquired facility in singing and playing are recorded. He is a born dancer or jumper, however, mingling this pastime with all his feasts. Dr. Rosse speaks in the highest terms of the Eskimo art talent and of the facility shown by some in learning the art of the higher race. Of the intelligence of the race the author has a high opinion. In speaking of their crania, Dr. Rosse confirms the results of Dr. Kohlmann, that there is no fixed Eskimo cranial type. As to character, uncontaminated, they are models of truthfulness and honesty; but as to chastity, Herder was far from truth when he wrote, "The blood of man near the pole circulates slowly, the heart beats but languidly: consequently the married live chastely, the women almost require compulsion to take upon them the troubles of a married life."

Owing to his hard life, the conflict with his circumstances, and his want of foresight, the Eskimo soon becomes a physiological bankrupt: and, his stock of vitality being exhausted, his bodily remains are covered with stones, around which are placed wooden masks, and articles that have been useful to him during life; or they are covered with driftwood, and the weapons and personal effects placed near by, in response to the sentiment commemorated by Schiller in 'Bringet hier die letzten gaben.'

— The Ottawa microscopical society held a conversazione on Nov. 20, at which nearly three hundred invited guests were entertained by the president and members. The admirable arrangement of the rooms allowed of a varied programme. Microscopes of various makers and models, and of highest grade, were set out in the upper story of the building; while the lower hall was devoted to music, elocution, the oxyhydrogen microscope, and the stereopticon. In the hands of the Rev. Dr. Ballaud, of the College of Ottawa, the gas-microscope and gas-lantern charmed all by the novelty and brilliancy of the objects and views presented to them. The entertainment lasted nearly three hours, and a repetition is eagerly demanded.

The general meetings of the society will be held this winter on Dec. 18, Jan. 15, Feb. 19, and March 18, at eight P.M., in the offices of the Geological survey.

— In accordance with the vote passed at the public meeting of the Archaeological institute of America, reported in SCIENCE, No. 41, the Hon. Samuel C. Cobb and Messrs. Henry Lee, William Endicott, jun., Oliver W. Peabody, and John C. Phillips have been appointed a committee to solicit subscriptions for the publication of the report of the investigations at Assos and for the general work of the institute. Twenty thousand dollars are needed; and subscriptions may be sent to either of the members of the committee, or to Henry L. Higginson, Esq., treasurer of the institute, No. 44 State Street, Boston.

— At the third annual meeting of the Natural science association of Staten Island, held in the village hall, New Brighton, Nov. 10, Dr. A. L. Carroll was chosen president; Samuel Henshaw, treasurer; Charles W. Lang, recording secretary; Arthur Hollick, corresponding secretary; and W. T. Davis, curator. The society numbers seventy, and has a balance in the treasury. Objects of interest were exhibited at this meeting by seven members, and consisted very largely of specimens collected in the immediate vicinity, — the highest sign of activity.

— The editor of the *American monthly microscopical journal* announces that the office of publication will be removed to Washington with the beginning of 1884.

— The Russian academy of science held its centennary anniversary at St. Petersburg with much ceremony on the second of last month, under the presidency of Count Tolstoy, the Russian minister of the interior.

— The *Moniteur industrielle* announces that the International exhibition at Marseilles opened on the 15th of November, and remains open until April 31, 1884. The programme is extensive, and, on the whole, embraces much the same range of subjects as the London fisheries exhibition.

— After the electrical exhibition in Paris, a number of French electricians formed themselves into a club, which has met once a month for a dinner. From this small beginning there has developed an 'International society of electricians.' The society numbers more than nine hundred members from twenty nationalities. Information may be had from Georges Berger, 99 Rue de Grenelle, Paris.

— Mr. Charles A. Ashburner of the State geological survey is completing his surveys and examinations in Cameron, Elk, and Forest counties, Penn. Mr. Ashburner's report, to be accompanied by maps and sections, will be published late in the winter, and will contain much information of interest to the coal and oil operators in this section of the state.

— The next issue of the Library of aboriginal American literature, published by Dr. D. G. Brinton, Philadelphia, will be 'The comedy of Gueguence,'

a play written and acted by the natives of Nicaragua. It dates from the seventeenth century, and is written in a curious dialect, half Aztec and half Spanish. It will be ready early in December.

— An itinerary has been issued of the first part of the map of the route of the Alaska military reconnaissance of 1883 by Lieut. Schwatka. The total length of raft-journey on the Yukon River from Lake Lindeman to Nuklakayet was 1,303.2 miles, being the longest raft-journey in the interest of geographical science. He gives the length of the Yukon River as 2,043.5 miles.

— At the meeting of the Engineers' club of Philadelphia, Nov. 17, Mr. Edw. I. H. Howell presented a sketch of the practice and peculiarities of the English machinists with regard to machine-tools. He also exhibited specimens of polished shafting, from 1⅛″ to 2⅞″ in diameter, cold drawn, like wire. The secretary, Howard Murphy, read an illustrated paper by Mr. G. T. Gwilliam, upon the methods of making and placing the mattresses and fascines at the extension of the Delaware Breakwater harbor. The secretary presented notes, by Mr. John J. Hoopes, to illustrate methods of computing tables by successive additions instead of separate calculations. Mr. John Haug presented illustrated notes upon boiler construction, touching especially upon what should be shown in drawings and specifications for boilers. Mr. George S. Strong exhibited specimens of cylindrical and corrugated flues; the former readily yielded to the pressure of the fingers, while the latter was trampled upon without injury. The secretary read, for Mr. C. J. Hexamer, a description of his experiments upon, with a discussion of the causes of, dust-explosions in mills. Mr. William A. Ingham considered that some explosions in coal-mines are probably attributable to the immense quantity of fine dust in the air; and Mr. T. Mellon Rogers, in response to Mr. Hexamer's comments upon the general absence of adjustable rolls in Philadelphia mills being a common cause of ignition by the friction of foreign metallic particles in the stock, spoke of their general use in the west.

— The mathematical section of the Washington philosophical society has resumed its sessions. At the meeting held Nov. 21, Mr. C. H. Kummell discussed the theory of errors as practically tested by target-shooting, in which he showed the effect of a difference of precision in the vertical and horizontal directions, and of taking account of the lost shots on the formulae employed.

— C. G. Stewart of St. Thomas's hospital, London, and Mr. G. Lathom Browne of the Midland circuit, have published the reports of various trials for murder by poisoning, from the trial of Tawell to that of Dr. Lamson. The book also gives directions for analysis, and points out difficulties that have occurred, or are likely to occur, in proving the presence of poison to a jury. The *Chemical news* considers the book "indispensable to all chemists who practise in toxicology, of great value to the medical profession generally, and doubtless no less so to solicitors and counsel who may be concerned in poisoning cases."

— The *Industrie-blätter* of Aug. 4 reports an ingenious fraud in jewelry. Thin plates of some precious stone, as for instance of emerald, have melted glass of the same color as the stone poured on one side. The real stone is set outside, so that, when tried, the jewel presents every appearance of being genuine and of the right hardness. These stones are called in the trade *pierres fines doublées.* The only test is to hold the stone edgewise, when, of course, the two sides will show different refraction. Any connoisseur will thus be able to detect the fraud; but, if set, this could hardly be done.

— The *Moniteur des fils et tissus* calls attention to a description of vegetable wool called kapoc. It comes from Java, and a specimen is on view at the Amsterdam exhibition. It arrives at Amsterdam in its leathery covering, being itself enveloped in the seeds. It is then freed from both, and is carded so as to make a very light mattress wool, worth about 8¾*d* per pound. One of the houses engaged in this operation had made trials in spinning and dyeing this material; but the filaments are said to be like strings, and their industrial application consequently a matter of uncertainty.

— The *Industrie zeitung* gives a description of the source of the much advertised Hunyadi Janos water. Fourteen springs rise in a marsh near the town of Ofen in Hungary, which is the property of Herr A. Saxlehnes of Budapesth. Four of the strongest springs flow into a cement-lined cistern, whence the water is pumped into a second reservoir and cleared, then passed through other purifying-vessels, until it is bottled by an ingenious arrangement, ten bottles being filled at once. The yearly sale amounts to about three million bottles.

— Caillaud communicates to the Geographical society of Paris some statements in regard to a plant of the strychnine family, native to Tonquin, to which remarkable virtues are ascribed. It is called by the Annamites, who make use of it, 'hoangnan.' It grows in the mountains which separate the valley of Mekong from southern Tonquin, and is a vine whose bark, in which the active principle exists, is a violent poison. Its use was communicated by a native convert to the missionaries. M. Lesserteur, formerly a missionary in Tonquin, and now director of the seminary of foreign missions, has published a pamphlet, in which he recounts numerous cases in which a cure was effected. Dr. F. Barthélemy of Nantes has also made a special study of the drug, which appears to act as an alterative and antispasmodic. It is also under investigation by the medical school of Alfort. Cures of active hydrophobia are claimed for it, and several cases mentioned in detail. It is also said to be an antidote to the venom of serpents, and to relieve cutaneous diseases. While under the effect of the drug, it is said that alcoholic liquor or heating food must be absolutely avoided as liable to induce active poisoning. Altogether, while there may be a valuable medical agent in this new drug, the accounts given of it recall those which heralded the introduction of the notorious South-American 'cundurango.'

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